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REPORT OF STUDIES ON UNIFORMITY OF QUALITY OF SUGARS

I. Chemical Studies on Beet Sugars of the 1940 Campaign

By C. A. Fort, S. Byall and R. M. Kingsbury

II. Report on Biological Studies of Sugars

By H. H. Hall

Agricultural Chemical Research Division,
Bureau of Agricultural Chemistry and Engineering,
U. S. Department of Agriculture.

July 1941

PART I.

CHEMICAL STUDIES ON BEET SUGARS OF THE 1940 CAMPAIGN

By C. A. Fort, S. Byall and R. M. Kingsbury
Bureau of Agricultural Chemistry and Engineering
U. S. Department of Agriculture

Samples of beet sugars representing the campaign composites of the sugar produced at each of the 83 factories operating during the 1940 harvest were received and have been examined chemically, physically and biologically. Four special samples were also submitted and were similarly studied. The factory operating data which accompanied the sugar samples and the chemical and physical test results obtained on the sugars will be presented in this portion of the report. The biological studies made by H. H. Hall will be found in the second part.

The tabular presentation of the data of all kinds is arranged somewhat differently than in previous reports. For example, the data have been grouped into smaller tables; those for non-Steffens and Steffens factories are tabulated and averaged separately; historical data have been limited to the averages for 1939 in some instances, and in others to averages for the three-year period of 1937-9, but there have been added tables showing the geographical group averages. Also in the presentation of chemical data, the determinations of potash and soda have been omitted and in their place there are determinations of sulphated ash, conductivity ash factors and estimations of total salts.

Operating Data

Beet and Pan Purities

Taking up the different phases of the work, let us first consider the data in tables 1 and 2. It will be seen that on the average the sucrose in beets of the past season was lower than in 1939. However, the diffusion juice purity was slightly better and led to an improved white-pan purity.

TABLE 1

PROCESSING PURITIES, SUCROSE AND BRIX -- NON-STEFFENS FACTORIES

Sample Number	Sucrose in Beets	Purities			Brix	Purities			Brix	Purities Raw Sugars	
		Diff. Juice	Thick Juice	White Pan	Wht. Pan	High Wash	High Green	Hi-Raw Pan	Hi-Raw Pan	High	Low
4002	15.6	85.7	92.3	92.2	91.8	92.6	86.5	85.1	94.4	97.7	89.6
4005	16.4	87.0	91.0	92.3	91.8	91.0	85.4	85.1	93.3	98.5	92.1
4006	17.7	83.9	89.7	92.1	91.9	91.1	85.8	85.8	93.7	97.6	92.3
4009	15.2	86.8	89.7	91.3	92.6	92.6	83.0	83.5	94.7	98.1	87.1
4013	15.9	87.0	92.1	90.0	92.3	89.1	79.6	--	--	--	(93.7)
4014	14.8	86.6	--	90.6	91.7	88.9	82.1	81.8	94.5	96.7	90.4
4015	16.0	88.5	--	92.1	91.9	91.4	84.3	83.8	92.2	97.3	91.3
4021	15.1	84.7	89.4	90.8	92.2	90.2	83.5	83.5	94.6	98.4	91.1
4022	16.9	86.9	--	92.6	90.7	91.7	86.1	86.1	92.8	98.0	89.6
4023	15.4	87.8	90.4	91.2	91.5	90.2	82.2	82.3	93.0	96.5	88.1
4028	16.6	89.5	--	92.6	91.0	91.3	86.0	84.9	91.6	96.9	91.9
4031	14.1	85.3	90.3	90.5	92.0	89.0	81.5	82.2	91.7	--	--
4033	14.4	86.5	91.2	90.7	91.8	87.8	82.4	81.1	92.5	98.2	95.9
4034	16.3	87.4	90.4	91.6	91.0	90.2	85.5	83.7	91.8	96.0	90.0
4037	14.0	86.2	89.9	91.1	91.3	90.1	83.4	82.0	93.8	97.2	85.8
4038	15.0	86.2	90.3	90.7	91.5	89.1	82.7	81.7	93.8	97.2	89.9
4041	15.4	85.9	--	89.8	90.6	87.7	80.3	--	--	--	(98.7)
4042	16.6	90.3	93.2	94.2	91.2	93.5	88.5	87.2	91.3	97.8	92.5
4044	15.7	88.0	90.2	91.7	91.6	90.0	83.6	81.0	94.7	93.5	88.4
4045 & 6	14.0	84.7	90.5	91.5	92.2	91.3	82.2	82.3	94.7	98.3	86.2
4047	16.4	87.5	91.1	91.3	91.6	88.3	84.2	84.6	94.4	96.9	88.2
4048	16.4	85.9	93.8	94.1	91.9	94.6	88.9	87.9	93.4	98.8	90.0
4049	15.5	85.9	--	87.7	92.5	94.9	76.2	--	--	--	(97.5)
4051	16.4	87.4	90.0	90.2	91.8	92.9	87.9	82.3	92.1	95.3	90.7
4053	15.0	85.2	89.8	93.2	90.0	94.4	87.0	87.0	90.7	98.6	93.7
4054	15.6	87.4	91.5	91.9	90.6	89.9	84.6	81.8	91.4	96.5	93.9
4055	16.0	87.9	89.4	90.0	91.5	90.2	83.3	82.9	93.2	95.8	89.0
4056	15.8	85.7	92.4	93.3	90.9	91.4	87.2	87.0	91.0	96.0	93.1
4057	16.5	88.8	91.6	92.5	92.3	91.1	86.3	84.9	93.5	97.4	91.2
4058	16.2	86.6	89.9	91.8	90.7	92.0	84.8	85.4	93.3	96.0	90.3
4059	15.7	86.6	--	90.8	90.3	90.8	85.9	83.4	91.4	96.2	92.8
4061	16.8	89.6	92.4	93.1	91.5	91.7	87.2	83.7	93.6	97.5	92.1
4063	17.4	87.7	92.8	94.6	92.1	94.3	89.1	85.0	93.0	99.0	97.7
4064	17.8	87.6	92.1	93.2	92.6	94.5	88.1	87.9	93.7	99.2	95.7
4066	17.2	88.7	--	92.1	91.4	90.5	86.2	84.3	95.1	98.0	87.4
4070	16.2	85.7	91.1	91.6	91.1	89.4	85.3	85.2	91.9	96.1	90.4
4072	16.0	84.3	89.3	92.5	91.6	93.0	84.9	86.8	92.5	99.3	95.3
4079	14.9	86.5	91.0	91.9	91.1	90.6	83.7	83.2	92.1	98.2	89.3
4080	15.3	88.3	92.2	93.6	92.4	92.8	87.5	83.9	93.9	98.3	93.2
4082	15.5	85.0	--	93.7	92.2	93.3	87.3	86.0	94.6	98.4	87.2
4086	16.0	86.1	89.0	91.3	91.4	90.6	84.9	83.5	94.3	96.8	90.3
Average	15.8	86.8	--	91.8	--	91.2	84.8	--	--	97.4	90.9
1939 Avg.	16.5	86.7	--	91.6	--	89.8	84.3	--	--	97.5	91.3

( ) Values for total remelt sugars.

TABLE 2

PROCESSING PURITIES, SUCROSE AND BRIX-- STEFFENS FACTORIES

Sample Number	Sucrose in Beets	Purities			Brix	Purities			Brix	Purities	
		Diff. Juice	Thick Juice	Wht. Pan	Wht. Pan	High Wash	High Green	Hi-Raw Pan	Hi-Raw Pan	Raw Sugars High	Raw Sugars Low
4001	17.3	85.9	91.1	92.2	90.5	89.8	85.3	86.1	91.9	99.0	97.1
4003	16.2	86.6	90.9	92.2	90.7	90.3	86.3	85.5	90.9	96.9	91.2
4004	16.2	87.2	--	92.0	91.4	91.6	86.2	85.8	92.2	97.1	92.7
4007	15.9	85.3	92.3	92.9	90.4	91.7	86.3	85.6	92.1	97.7	93.3
4008	14.7	86.1	90.7	91.4	90.0	89.9	85.1	83.8	91.9	95.5	86.8
4010	17.8	86.2	89.7	92.6	90.7	95.3	87.3	86.5	92.1	99.5	96.3
4011	16.9	84.7	--	91.2	91.2	91.3	84.3	84.6	91.6	97.7	94.7
4012	15.7	86.7	--	93.9	90.6	92.7	87.8	88.2	90.0	98.1	97.0
4016	15.1	87.6	--	93.5	90.7	92.4	88.1	88.3	91.0	99.2	96.8
4017	17.7	86.1	90.9	91.6	90.1	88.9	84.4	85.8	91.1	99.0	98.0
4018	16.8	89.3	--	93.4	90.6	91.2	87.8	87.9	89.5	97.2	95.3
4019	14.4	83.6	89.6	92.3	90.1	92.0	85.3	87.4	91.1	99.3	96.7
4020	16.0	86.2	--	92.7	90.5	90.8	86.5	86.7	89.0	97.7	95.0
4024	14.2	87.0	90.0	91.3	90.6	90.3	84.3	83.8	91.7	96.6	89.3
4025	14.7	87.0	92.0	93.6	91.7	93.1	87.5	86.2	89.9	98.4	97.3
4026	16.2	89.4	92.4	92.7	90.4	92.2	86.7	85.4	92.2	98.3	96.1
4027	15.3	88.0	91.3	91.6	91.0	88.7	85.9	85.2	91.4	97.0	91.5
4029	15.3	86.1	--	92.7	90.9	81.6	86.5	87.0	91.0	98.6	95.1
4030	15.8	88.0	91.3	92.8	90.8	91.4	84.8	85.0	91.7	97.1	90.0
4032	14.5	85.3	89.7	92.1	90.6	91.7	84.3	85.7	91.6	99.4	94.9
4035	15.5	86.8	92.6	91.6	91.6	89.8	83.3	--	--	--	(95.4)
4036	14.9	86.0	--	92.1	90.9	92.1	86.2	86.1	92.9	96.4	92.0
4039	14.7	86.9	91.3	92.5	92.3	91.3	86.1	86.0	92.2	97.4	90.4
4040	15.2	87.6	91.3	92.3	90.7	91.0	85.7	84.4	91.4	96.9	89.0
4043	13.8	84.5	90.1	91.0	90.5	88.8	85.0	82.6	92.6	95.8	89.4
4050	15.9	88.5	90.6	90.9	90.8	89.4	85.3	83.2	91.2	95.7	89.4
4052	15.6	87.8	--	90.9	91.5	88.6	84.9	84.0	91.9	96.9	90.9
4060	17.6	87.6	91.3	93.5	91.5	(87.8)	--	86.8	92.5	98.7	97.0
4062	14.9	85.4	--	90.8	91.1	89.3	83.5	81.9	92.3	97.4	85.7
4065	15.9	88.5	91.7	93.2	90.4	91.0	87.7	86.4	91.8	96.3	90.7
4067	17.7	88.9	92.0	93.4	92.0	(87.9)	--	87.7	92.5	98.2	97.0
4068	14.4	85.4	--	90.4	92.6	87.3	81.5	81.2	91.3	96.6	92.5
4069	16.0	83.2	89.0	92.6	92.4	91.9	85.7	86.0	94.0	98.4	94.9
4071	15.8	87.1	--	91.7	92.0	90.0	84.6	85.1	91.7	97.5	92.6
4073	14.0	79.9	87.5	88.0	91.8	86.2	79.6	83.5	86.4	97.3	95.6
4074	16.4	86.9	--	93.0	91.0	89.5	85.9	86.9	91.0	98.7	97.1
4075	17.7	86.4	--	95.3	91.7	95.4	90.0	88.5	93.4	98.9	94.2
4076	16.7	89.7	92.7	93.1	91.0	91.6	88.4	86.7	92.6	98.0	93.7
4077 & 8	14.9	84.6	--	90.9	92.0	91.1	82.8	81.9	94.3	97.7	87.6
4081	15.1	86.7	92.8	94.3	91.9	95.2	88.7	88.7	92.3	98.8	92.3
4083	19.0	86.6	92.1	92.4	91.0	90.9	84.3	86.9	91.8	98.5	92.7
4084	17.5	82.7	--	91.3	91.6	89.5	83.1	86.8	92.3	98.2	94.2
*4085	12.5	69.9	92.6	83.9	92.1	81.3	75.1	80.9	86.3	98.0	93.7
Average	15.8	86.4	--	92.2	--	90.7	85.6	--	--	97.7	93.3
1939 Avg.	16.3	85.9	--	91.8	--	90.0	84.9	--	--	97.7	92.9

*Not included in average

( ) Value for total remelt sugar.

From a study of earlier reports it is noted that in recent years the white pan purity almost exactly parallels the juice purity indicating that the juice purification obtained and the proportion of raw sugars reprocessed are quite constant.

The increase in high green purity over 1939 is slightly greater than would be expected from the small increase in white pan purity. This is possibly traceable to the tendency to make the cut between high wash and high green at such a point that more of the wash goes into the green, thus increasing the purity of both. On the average the Brix of the white pan is essentially unchanged from that used in 1939 indicating again a general uniformity in factory operations from year to year. It may be noted that the white pan purity of Steffens factories averageshigher as would be expected. The lower white pan Brix of Steffens factories is, however, lower than would be anticipated from the slightly higher purity and may indicate a general tendency for Steffens factories to boil their white pans somewhat lighter at a given purity. This possibly aids in obtaining an improved white sugar and may also correlate with the fact that Steffens sugars average slightly finer in grain size. These same differences exist in the case of the high raw pans, Steffens factories boiling their high raws at an average of 1.3 degrees higher purity and with 1.5 degrees lower Brix.

Remelt Sugars.

The quality of high raw sugars tends to be uniform but the trend for low raws is different. Steffens factories tend to produce a higher polarizing low raw, which was higher in the current season than in 1939, while the non-Steffens low raws are of lower purity and lower this year than last. All factories save four now use a three-boiling system, and a high degree of operating uniformity is evidenced both by the operating

data and, as will be seen later, by the greater uniformity in sugar quality.

The reprocessing of low raw sugars has changed some in recent years in respect to the increased introduction of low raw melts into the feed for high raw pan rather than into the first liquor for the white pan. While in 1936, as well as this year, about 74% of low raws were reintroduced at either first or second carbonation or into the raw juice, the proportion introduced directly into first liquor has decreased from 22% in 1936 to 11% in 1940; the amount going to the high raw pan has increased from 3% to 14%. This trend may be advantageous in its effect on white sugar composition through improvement in white pan purities.

Liming and Carbonation

In tables 3 and 4 may be noted a further reduction in the amount of lime used in both Steffens and non-Steffens factories. Some 37% of the factories use some lime in second carbonation, usually around a quarter of a percent on beets. The use of soda ash is necessarily more common and in greater amounts in Steffens factories than in non-Steffens. The uniformity of operating practices is well shown by the average alkalinities of first and second carbonation. Since data are not given in tables in respect to the kind of carbonation used the general statement will be made that in 1940 31% of Steffens and 76% of the non-Steffens used batch type first carbonation while on second carbonation the corresponding percentages were 14% and 17%. Going back to 1936 for contrast, at that time 57% of the Steffens and 90% of the non-Steffens factories used batch type first carbonation and the second carbonation figures were respectively 17% and 27%. The increased use of continuous first carbonation in this four year period is quite striking.

In connection with the data on pH values it may be pointed out that the drop in pH from second carbonation to thin juice, due primarily to the sulphuring of thin juice, averaged practically the same in both years. The slightly lower decrease in the case of the Steffens factories agrees with the smaller amount of sulphur burned by them. The change from thin juice to thick juice, produced by concentration in the evaporators, is seen to be quite different at various factories. While on the average, Steffens house thin juice tends to drop in pH on concentration and non-Steffens juice tends to increase in pH, there are a number of exceptions in both instances. The pH values of first liquor and of the white pans are still widely variable between factories but no effects on uniformity of sugar quality can be traced. Pan pH varied from 7.4 to 9.2 and averaged lower for the Steffens factories by 0.25 unit.

Sulphuring

The amount of sulphur used has been considerably reduced in recent years. The difference in averages between 1940 and 1939 is not great but still shows this trend (see tables 5 and 6). Going back to 1936 reports it is noted that all but 15% of the factories used more than 0.40 lbs. sulphur per ton while in the present year roughly 50% of them use less than this amount. At present some 73% of the non-Steffens and 66% of the Steffens factories sulphur thin juice only while 7% and 14% respectively sulphur thick juice only; the remainder, about 20% in each case, sulphur both.

TABLE 3

ALKALINITIES IN PROCESSING NON-STEFFENS FACTORIES

Sample Number	Total CaO used	CaO to 2nd Carb.	Soda Ash used per ton	Alkalinities		pH Values				Lime Salts
				1st Carb.	2nd Carb.	2nd Carb.	Thin Juice	Thick Juice	1st Liquor	1st Liquor
	% beets	% beets	lbs.							
4002	2.41	0.2	0.03	0.083	0.017	8.8	8.4	9.1	9.0	0.026
4005	2.85	--	0	.080	.020	8.9	8.5	8.5	8.5	.048
4006	3.60	.1	0	.088	.018	--	--	8.8	8.8	.037
4009	1.21	0	0.35	.084	--	9.3	7.7	8.1	8.2	.015
4013	2.08	.2	0	.094	.041	--	--	--	8.0	--
4014	1.20	0	.18	.084	--	9.4	8.2	8.7	8.6	--
4015	2.50	0	0	.099	.016	--	8.5	8.9	8.2	.021
4021	1.93	.2	.08	.091	.024	--	8.9	9.4	8.6	.065
4022	2.46	0	0	.103	.021	8.8	8.6	9.3	8.8	.020
4023	1.34	0	.02	.073	--	9.3	8.1	8.6	8.6	.017
4028	2.72	0	0	.085	--	9.0	8.0	7.9	7.8	.025
4031	1.59	0	.67	.082	--	9.3	8.0	9.1	9.1	.047
4033	2.20	0	0	.095	.021	--	8.5	8.8	8.4	.042
4034	2.35	0	.40	.096	--	8.6	8.2	8.8	8.8	.076
4037	1.40	.03	.25	.079	--	9.2	7.7	8.7	8.7	.022
4038	1.37	0	.14	.080	--	9.4	7.7	8.8	8.7	--
4041	2.50	0	0	.080	.021	--	8.5	8.7	8.6	.013
4042	2.08	.03	0	.067	.019	9.5	7.7	8.3	8.4	.010
4044	1.19	0	.14	.068	--	9.2	7.9	8.8	8.7	.015
4045-6	1.44	.15	.02	.081	--	9.5	7.8	9.1	8.9	.012
4047	1.88	0	.03	.071	.014	--	8.0	7.8	7.9	--
4048	2.15	0	.15	.082	--	8.6	8.2	--	9.2	.036
4049	2.50	0	--	.073	.020	--	7.8	7.8	7.9	.059
4051	2.05	0	.37	.070	.015	--	7.7	7.4	7.4	--
4053	2.15	.25	.12	.088	.027	8.8	8.5	7.6	7.6	--
4054	2.18	.05	0	.098	.015	8.8	8.8	8.8	8.2	.045
4055	1.59	0	.06	.073	.016	--	7.8	7.9	7.8	--
4056	2.50	.25	.07	.088	.017	8.5	8.5	9.4	8.3	.056
4057	2.40	.15	0	.081	.014	--	8.3	9.2	9.1	.015
4058	2.27	0	1.10	.079	.017	--	8.3	8.5	8.5	.038
4059	2.50	.10	0	.078	.008	--	8.0	--	8.4	--
4061	2.12	0	.03	.077	--	9.0	7.9	8.7	8.7	.040
4063	2.45	.07	0	(pH 11.2)	--	9.1	8.6	8.9	8.6	.029
4064	2.40	.10	.24	.066	.017	8.8	8.3	8.1	8.0	.032
4066	1.22	0	.07	.079	--	9.4	7.9	8.7	8.6	.009
4070	1.90	0	.05	.078	--	9.1	8.0	--	8.1	.025
4072	2.29	0	.19	.088	.031	--	8.6	8.4	8.2	.032
4079	1.63	.20	.20	.067	--	9.2	7.8	8.3	8.3	.018
4080	2.64	.50	.41	.078	.016	9.0	8.5	8.4	8.4	.054
4082	1.71	.15	.17	.069	--	9.0	7.9	8.8	8.6	.022
4086	2.50	0	.06	.075	.021	--	8.4	8.8	8.7	.034
AVG.	2.08	0.07	0.14	.081	.019	9.05	8.16	8.59	8.44	.032
1939 AVG.	2.20	--	--	.083	.019	9.05	8.18	8.63	8.42	.033

TABLE 4

ALKALINITIES IN PROCESSING STEFFENS

Sample Number	Total CaO used	CaO to 2nd Carb.	Soda Ash used per ton	Alkalinities		pH Values				Lime Salts
				1st Carb.	2nd Carb.	2nd Carb.	Thin Juice	Thick Juice	1st Liquor	1st Liquor
	% beets	% beets	lbs.							
4001	5.30	0.25	0	0.050	0.015	--	--	--	7.2	0.075
4003	4.45	0	0.98	.065	.013	8.8	8.2	7.9	7.9	.071
4004	3.91	.17	.63	.069	.015	8.8	8.3	8.2	8.2	.055
4007	4.58	.25	.06	.089	--	9.1	8.6	--	8.5	.081
4008	2.99	0	.16	.073	--	9.0	8.1	9.0	8.4	.009
4010	5.22	.20	1.60	.074	.015	8.9	8.1	7.5	7.5	.044
4011	3.89	0	1.05	.063	.019	--	8.4	8.2	8.2	.073
4012	4.04	.20	0.49	.089	.016	8.5	8.3	8.2	8.0	.055
4016	4.26	0	.20	.066	.017	--	7.8	7.9	7.9	.032
4017	4.65	0	0	.055	--	8.7	8.7	8.6	7.6	.137
4018	3.73	0	.01	.078	--	9.0	8.4	--	8.1	.036
4019	3.71	0	.59	.092	.019	9.1	8.0	7.6	7.6	.045
4020	5.33	.15	1.34	.086	.012	8.5	7.9	8.7	8.7	.040
4024	2.31	0	0.40	.064	--	9.1	7.8	8.4	8.4	.024
4025	4.60	0	0	.085	.013	8.9	9.0	9.0	8.3	.059
4026	3.05	.18	.50	.094	.015	8.7	8.6	8.8	7.9	.042
4027	3.59	0	0	(pH 11.1)	--	8.9	8.4	--	8.7	.058
4029	4.91	.30	1.54	.089	.019	9.1	9.0	9.0	8.6	.049
4030	3.08	0	0.45	.065	--	9.2	7.9	8.0	8.0	.036
4032	3.89	.05	.30	.075	.013	--	7.9	7.2	8.1	.133
4035	4.38	.10	.30	.069	.027	9.2	--	--	8.6	.019
4036	3.81	.16	.27	.071	.013	9.2	8.4	--	8.5	.046
4039	3.66	0	.04	.076	--	9.2	7.8	8.4	8.4	.017
4040	3.05	0	.17	.077	--	9.1	7.5	8.5	8.5	.021
4043	3.15	0	.04	.067	--	9.0	8.0	9.0	8.9	.014
4050	3.07	1.00	.16	.078	.011	--	7.8	7.2	7.0	--
4052	3.70	0	.74	.062	.012	--	8.1	7.8	7.7	.049
4060	3.54	0	0	--	--	(7.7)	(7.4)	8.1	(7.1)	.101
4062	2.96	0	1.06	.062	--	9.2	7.7	8.1	8.3	.029
4065	2.79	0	1.18	.067	--	9.0	7.6	8.3	8.3	.031
4067	3.40	0	0.19	(pH 11.0)	--	9.0	8.4	8.1	8.1	.124
4068	3.33	0	1.02	.072	--	9.3	7.8	8.0	8.0	.028
4069	4.67	0	1.67	(pH 11.2)	--	9.2	9.1	--	8.8	.051
4071	3.33	.10	0	.079	--	9.2	8.6	--	8.0	.026
4073	4.02	0	1.27	.067	--	8.2	8.1	9.2	8.1	.078
4074	3.21	.20	0.65	.084	.014	8.7	8.3	9.0	8.9	.041
4075	3.31	0	1.23	.069	--	9.9	9.9	9.3	9.2	.040
4076	3.68	0	0.26	.079	.017	9.3	8.4	8.3	8.4	.079
4077-8	2.48	0	0.99	.067	--	9.4	8.1	8.3	8.4	--
4081	3.76	0	.28	.073	.013	8.8	8.2	7.9	7.9	--
4083	3.46	0	1.00	.081	--	9.0	8.5	7.5	7.6	.097
4084	3.72	0	1.33	.092	--	9.0	8.5	7.5	7.6	.092
4085	6.65	0	7.23	.051	--	8.1	7.9	8.9	7.8	.328
Average	3.76	.08	0.66	.074	.015	8.97	8.24	8.26	8.17	.055
1939 AVG.	4.10	--	--	.075	.016	9.01	8.28	8.32	8.19	.060

TABLE 5

MISCELLANEOUS OPERATING DATA NON-STEFFENS

Sample Number	Sulphur used per ton	Carbon used per 100 sug.	Filter Aid Used per ton	Filtration 1st Liquor Temp.	Filtration 1st Liquor Brix	Wash-water used on Wht. Sugar Temp.	Wash-water used on Wht. Sugar per mach. per 100 sug.		Sacking of White Sugar Temp.	Sacking of White Sugar Moisture
	lbs.	lbs.	lbs.	C°		C°	Qts.	Qts.	Co	
4002	0.44	0.08	0.37	96	70.2	95	15	5.2	64	0.039
4005	.26	.17	.83	96	68.3	93	20	8.0	57	.025
4006	.23	0	.76	92	64.1	90	12.5	3.1	43	.028
4009	.49	0	.32	92	68.3	91	18	6.4	34	.020
4013	.38	0	.50	95	60.0	95	15	3.0	60	.015
4014	.41	0	.29	88	70.7	92	17	6.7	38	.023
4015	.88	.19	.61	97	64.2	90	14	4.0	40	.021
4021	.52	.28	.38	90	62.7	95	18	7.2	43	.035
4022	.51	.22	.66	93	71.9	90	16	6.5	51	.023
4023	.50	0	.26	88	72.3	93	17	6.1	37	.027
4028	.58	0	.42	98	70.6	88	16	4.8	52	.041
4031	.83	0	.22	80	68.4	90	16	4.0	31	.018
4033	.32	.12	.42	92	62.9	86	14	4.6	43	.028
4034	.51	.13	.51	85	62.2	90	16	5.2	68	.036
4037	.57	0	.18	89	68.9	90	17	4.7	39	.028
4038	.56	0	.29	91	69.8	94	16	6.2	40	.024
4041	.34	0	.42	95	61.9	95	17	5.7	58	.035
4042	.67	.10	.67	92	72.6	92	18	6.0	54	.029
4044	.53	0	.27	89	70.5	91	17	6.8	34	.017
4045	.57	.20	.33	89	69.0	89	17	5.7	39	.030
4046	.57	0	.33	89	69.0	89	17	5.7	39	.030
4047	.53	.11	.42	91	69.8	89	14	4.6	69	.035
4048	.21	.11	.59	96	69.0	95	14.5	4.9	48	.022
4049	.51	0	.14	94	60.0	87	21	6.0	61	.020
4051	.60	.15	.51	92	65.8	89	14	4.1	53	.031
4053	.52	.13	.58	90	69.1	94	22	7.8	46	.031
4054	.26	.11	.46	97	64.9	85	15	6.1	48	.025
4055	.51	.15	.48	93	65.4	94	15	4.3	43	.026
4056	.31	.19	.59	95	61.1	90	16	4.0	64	.050
4057	.39	.12	.72	96	66.5	96	17	7.5	42	.033
4058	.35	.16	.49	92	71.6	91	16	6.2	63	.031
4059	.45	0	.50	95	60.0	80	12	--	70	.035
4061	.36	.13	.50	92	70.2	95	18	5.7	52	.036
4063	.15	0	.23	92	69.7	90	14	5.5	49	.027
4064	.39	.16	.76	88	69.2	91	18	6.0	43	.019
4066	.57	.03	.22	87	68.6	90	16	4.9	44	.022
4070	.44	.06	.31	99	71.7	96	16	5.2	54	.030
4072	.52	.20	.55	92	69.6	94	19	5.4	51	.029
4079	.58	0	.24	84	66.1	96	16	--	40	.021
4080	.22	.20	.47	93	69.6	97	16	6.4	50	.031
4082	.47	.07	.33	99	67.8	98	14	4.0	53	.022
4086	.41	.07	.38	91	68.9	110	13	3.0	54	.033
Average	0.46	0.09	0.44	92	67.4	92	16	5.4	49	.028
1939 Avg.	0.50	0.09	0.46	92	67.1	90	15	5.1	50	.031

TABLE 6

MISCELLANEOUS OPERATING DATA STEFFENS FACTORIES

Sample Number	Sulphur used per ton beets	Carbon used per 100 sug.	Filter Aid per ton beets	Filtration 1st Liquor Temp.	Filtration 1st Liquor Brix	Wash-water used on Wht. Sugar Temp.	Wash-water used on Wht. Sugar per mach.	Wash-water used on Wht. Sugar per 100 sug.	Sacking of White Sugar Temp.	Sacking of White Sugar Moisture	Molasses Worked % beets
	lbs.	lbs.	lbs.	C°		C°	qts.	qts.	C°	%	%
4001	0.30	0	0.80	90	61.9	90	13	4.4	43	0.045	6.50
4003	.39	0.12	.62	93	68.7	94	15	6.5	40	.050	8.10
4004	.31	0	.63	93	68.4	93	16	5.3	31	.046	7.01
4007	.29	.09	.41	92	66.4	98	16	6.5	54	.037	7.00
4008	.49	0	.39	90	71.5	90	18	6.0	38	.043	5.45
4010	.49	.14	.50	95	68.0	91	19	4.2	52	.050	9.69
4011	.33	.07	.69	95	68.7	70	14.5	5.0	54	.039	6.24
4012	.51	.10	.53	98	60.3	85	14	4.7	42	.028	5.30
4016	.64	.18	.70	95	70.8	95	19	--	44	.050	6.84
4017	.18	.06	.78	92	66.8	88	13	5.0	52	.032	7.07
4018	.30	.04	.26	83	71.0	89	18	7.2	55	.029	5.79
4019	.54	.28	.30	--	67.3	100	15	5.2	58	.038	5.41
4020	.33	.17	.68	96	70.1	91	14	--	53	.048	8.81
4024	.44	0	.49	89	67.9	91	15	5.7	41	.040	4.09
4025	.42	.26	1.00	98	64.9	88	20	6.8	45	.043	5.44
4026	.33	.10	0.73	93	63.4	87	16	5.0	55	.035	4.42
4027	.53	.05	.34	87	66.0	86	15	6.0	61	.048	5.98
4029	.20	.67	.84	95	66.4	95	21	7.0	65	.036	7.78
4030	.33	0	.43	98	70.4	96	18	6.0	40	.029	5.98
4032	.32	.13	.36	93	71.2	95	15	--	46	.042	8.23
4035	.35	0	.93	93	64.3	106	14	4.5	67	.032	3.59
4036	.31	.08	.32	95	67.9	88	13	4.3	56	.035	5.93
4039	.48	0	.50	95	71.5	94	16	4.8	32	.015	6.09
4040	.35	0	.44	100	69.8	91	17	6.0	42	.032	5.73
4043	.52	0	.54	88	71.7	87	16	4.9	49	.032	5.48
4050	.35	.12	.82	91	63.2	89	16	4.6	38	.033	6.04
4052	.36	.16	.77	87	69.4	88	18	9.0	51	.030	6.77
4060	.22	0	.30	91	65.2	99	20	4.7	26	.025	6.09
4062	.54	0	.48	90	70.4	95	18	5.0	37	.028	6.14
4065	.42	.10	.44	90	70.1	92	18	5.0	42	.022	4.99
4067	.22	0	.50	96	65.6	83	12.6	4.0	45	.028	6.66
4068	.55	0	.57	89	69.1	89	14	3.1	49	.021	6.42
4069	.25	.18	.58	87	72.8	95	19	5.0	44	.025	7.07
4071	.41	.09	.38	98	67.2	94	18	4.5	53	.032	5.72
4073	.45	.20	.67	90	59.0	95	18	7.5	51	.041	6.12
4074	.27	.20	.51	97	68.0	94	15	5.0	54	.053	5.18
4075	.20	.16	.44	67	71.7	92	16	5.0	41	.015	7.44
4076	.32	.04	.51	93	69.3	91	17	4.0	31	.027	6.33
4077	.56	.11	.60	90	68.7	92	13	5.1	42	.017	4.90
4078	.56	0	.60	90	68.7	92	13	5.1	42	.017	4.90
4081	.31	.17	.84	91	67.9	96	18	3.5	53	.023	5.02
4083	.35	.06	.85	96	69.6	91	15	5.1	48	.043	5.62
4084	.48	.11	.76	95	68.7	91	14	4.8	48	.039	7.89
*4085	.85	.39	1.15	90	53.8	95	18.5	7.7	51	.038	10.90
Average	0.38	0.10	0.58	92	66.3	91	16.2	5.3	47	.035	6.25
1939 Avg.	0.40	0.11	0.60	92	66.8	91	15.7	5.3	48	.036	6.71

*Not included in averages

Filtration Data

The average use of filter-aid seems to have reached rather stable values with the consumption by Steffens factories nearly one third greater than that by non-Steffens. Filtration conditions for first liquor have tended to change to filtrations at higher density. In 1936 some seven factories still filtered at below 60° Brix and only four at 70° Brix or over. In 1940 only one factory filtered at below 60° and that was close, being 59.0°, and eighteen filtered at 70° Brix or above. The trend shown by comparison of the 1940 and 1939 averages was in this direction although the contrast is not great. The temperatures used are essentially unchanged.

Washing and Sugar Drying

The amount of wash water used averaged slightly more in 1940 than in 1939 with average temperature little changed. In recent years, however, the temperature of the wash water has generally tended upward. Going back to 1936 it is noted that 65% of the factories used a water temperature below 90°C while for 1940 only 25% were below this value. The tendency is to operate the grandulators at lower temperature and sack the sugar at lower temperatures. This trend still holds for the 1940 data as compared with 1939. Moisture contents of sugars are all satisfactorily low and uniform.

Molasses Worked

The molasses worked, as percent on beets, shows an appreciable decrease in 1940 as compared with the rather uniform percentages reported for recent years. Market conditions may partly account for this rather than any decrease in the molasses produced, although the average sucrose in molasses produced by non-Steffens factories was roughly 0.1% sucrose on beets lower than the 1937-9 average.

To summarize the operating conditions it may be repeated that there is considerable evidence that standardization of operating practice has continued to progress. Among the improvements noted are the use of less sulphuring, higher filtration concentrations, higher temperatures on wash water, the maintenance of high purities on white pans and general observance of the essentials that go into the making of a uniform high quality sugar.

STUDIES OF THE SUGARS

Ash Content

Discussing tables 7-14, inclusive, the ash content will first be considered. Tables 7 and 8 give the carbonate ash for the sugars and tables 9 and 10 repeat the carbonate ash and give the corresponding sulphated ashes. The carbonate ash values average lower than ever before. While in 1936 only around 25% of the sugars were below 0.01% ash now nearly 60% are below this value. It may be mentioned that this year's values for ash are the average of four or more determinations by two chemists. Carbonate ash is unquestionably a difficult value to obtain accurately and greater care must be used in its estimation than is commonly practiced. Both Steffens and non-Steffens sugars are seen to have improved in ash content; there is about a 11% decrease in the case of the non-Steffens and 8% for the Steffens sugars as compared with 1939.

The question may well be asked as to what produced this improvement. It cannot be pan purities alone for that has changed so slightly nor washing alone for the gain in this respect was small also. Without continuing this reasoning it is best to just assume that a little improvement here and there has had the cumulative effect of considerably improving the uniform quality of beet sugars in respect to this factor.

The sulphated ash figures given are for total sulphated ash.

TABLE 7

GENERAL ANALYTICAL DATA ON SUGARS -- NON-STEFFENS

Sample Number	Ash (Carb)	Color B-K index	Turbid- B-K index	SO_2 p.p.m.	Formula rating	Foaming test	Reflect- ance B-K	Barley Candy Color B-K	Barley Candy Reducing Sugars	Barley Candy Sucrose
4002	0.0072	6.5	10.2	4	75.7	95--75	92.8	8.6	3.6	95.8
4005	.0082	6.4	16.0	4	69.0	90--80	91.5	11.4	2.3	95.1
4006	.0093	3.6	12.4	2	74.5	95--80	92.5	12.3	2.6	95.5
4009	.0082	5.9	10.9	15	73.5	90--80	93.6	10.6	3.0	94.5
4013	.0098	9.3	22.3	14	57.3	95--80	92.3	15.6	2.7	95.8
4014	.0107	5.6	15.7	14	66.6	90--85	92.5	12.8	2.3	95.5
4015	.0104	7.4	12.0	10	69.2	95--80	93.6	14.3	3.8	95.1
4021	.0114	5.7	14.3	7	67.9	95--85	92.5	11.1	3.6	95.7
4022	.0080	4.2	9.8	5	74.5	100--85	92.8	12.7	2.2	96.0
4023	.0076	2.2	12.7	10	77.5	95--85	91.6	13.6	4.2	94.9
4028	.0089	1.3	9.6	25	77.7	100--85	92.7	13.2	2.1	94.0
4031	.0072	4.8	10.4	5	77.1	95--80	90.3	8.4	3.6	95.2
4033	.0069	13.4	17.4	1	62.2	90--80	91.2	11.0	1.8	95.8
4034	.0107	14.8	27.0	3	47.2	90--85	91.2	14.2	1.5	94.6
4037	.0086	3.1	10.3	11	76.9	95--85	92.0	9.8	2.2	95.8
4038	.0109	7.4	8.5	10	72.2	105--85	93.0	12.5	1.7	96.1
4041	.0157	10.3	15.5	3	58.2	100--90	93.2	20.4	1.9	95.7
4042	.0097	6.2	15.2	23	66.6	90--75	93.8	13.0	2.0	95.2
4044	.0073	5.7	21.5	10	64.5	100--90	92.1	9.6	3.2	94.3
4045	.0096	3.4	17.7	2	69.1	110--85	92.8	9.5	2.9	95.1
4046	.0077	4.9	13.3	2	73.9	100--80	92.4	10.1	2.6	94.8
4047	.0134	15.9	37.7	24	30.6	85--80	93.4	22.3	2.9	94.5
4048	.0078	6.1	10.7	2	75.2	90--80	93.5	10.5	2.2	94.5
4049	.0090	7.7	18.6	5	64.2	95--90	91.4	12.3	1.9	95.7
4051	.0147	14.2	26.6	25	42.0	90--80	93.2	20.0	3.0	94.6
4053	.0071	9.2	16.3	7	66.7	95--80	93.4	11.2	2.0	95.2
4054	.0084	5.6	9.5	4	76.1	100--90	93.1	12.1	1.7	95.4
4055	.0096	3.8	11.8	15	73.3	90--80	94.5	12.2	3.0	93.9
4056	.0177	10.3	27.0	7	44.3	90--80	90.4	19.4	2.3	95.7
4057	.0081	4.9	13.2	5	73.3	85--80	93.8	10.6	2.0	94.6
4058	.0095	5.3	11.7	6	72.9	85--80	94.5	13.2	2.8	94.3
4059	.0131	9.0	28.5	9	48.5	90--85	90.5	15.0	2.4	94.8
4061	.0086	4.7	12.4	5	73.8	100--80	93.2	9.5	2.7	95.2
4063	.0058	9.8	17.7	2	66.5	95--80	93.5	7.1	3.2	95.1
4064	.0066	13.6	27.7	7	51.4	85--75	93.2	13.0	3.1	95.2
4066	.0095	7.5	10.5	13	71.2	100--80	93.4	8.4	2.3	95.5
4070	.0101	8.3	17.3	14	62.9	95--80	92.6	13.8	2.1	96.3
4072	.0073	6.1	10.1	7	75.7	95--85	93.2	9.3	2.5	95.5
4079	.0071	6.6	9.7	12	75.4	90--80	94.0	6.6	2.5	95.2
4080	.0057	8.0	10.7	4	75.2	85--80	94.2	8.1	2.7	95.2
4082	.0083	5.1	8.2	6	77.8	100--85	94.7	8.1	2.3	95.8
4086	.0111	4.4	15.3	6	68.6	105--80	93.5	14.0	2.4	95.2
Avg. 1939	0.00934	7.10	15.57	8.7	67.05	94--82	92.8	12.18	2.57	95.19
Avg.	0.01056	5.92	14.87	12.0	67.45	97--85	91.6	11.71	1.65	96.57

TABLE 8

GENERAL ANALYTICAL DATA ON SUGARS -- STEFFENS

Sample Number	Ash (Carb)	Color B-K index	Turbid- B-K index	SO_2 p.p.m.	Formula rating	Foaming Test	Reflect- ance B-K	Barley Candy Color B-K	Barley Candy Reducing Sugars	Barley Candy Sucrose
4001	0.0110	21.4	47.5	10	19.1	95--80	89.4	16.4	2.5	96.4
4003	.0114	9.9	16.8	4	61.5	105--100	92.2	12.5	2.2	96.1
4004	.0091	11.2	17.3	5	61.9	95--95	91.8	12.9	2.5	95.7
4007	.0121	8.4	21.4	4	57.7	90--80	92.3	11.3	2.8	95.4
4008	.0106	4.8	15.8	9	67.9	100--85	91.5	10.7	2.2	95.7
4010	.0093	11.7	14.3	4	64.3	90--85	93.2	14.4	2.1	96.3
4011	.0080	8.3	14.0	5	69.2	90--80	93.0	10.0	2.9	94.8
4012	.0082	7.5	18.5	5	65.3	90--75	93.4	11.2	3.0	95.1
4016	.0179	6.6	15.0	20	58.5	95--85	93.4	14.8	3.2	96.0
4017	.0114	9.3	14.5	2	64.6	100--90	93.6	16.9	3.0	95.7
4018	.0072	6.6	18.3	8	67.1	90--90	92.8	8.9	2.7	96.0
4019	.0110	8.9	17.7	9	61.5	90--85	93.5	14.1	2.5	96.3
4020	.0114	7.9	17.0	5	63.2	95--80	92.7	17.8	2.4	96.0
4024	.0128	6.4	12.5	7	67.6	95--85	92.3	10.6	3.5	94.9
4025	.0090	10.5	31.0	3	49.2	90--80	89.2	11.4	2.9	94.6
4026	.0104	8.1	15.5	10	65.0	90--85	91.8	16.3	2.6	94.9
4027	.0163	7.6	11.0	8	64.3	95--90	92.6	22.1	2.5	96.3
4029	.0110	11.3	11.5	3	65.9	90--80	91.4	15.6	2.1	94.9
4030	.0095	6.3	12.5	8	70.9	95--80	91.7	11.5	2.0	94.5
4032	.0068	8.3	15.0	3	69.6	90--75	92.5	10.8	3.3	93.6
4035	.0155	6.7	10.8	10	66.0	100--85	92.7	18.4	2.0	95.8
4036	.0108	7.7	12.7	4	68.4	95--85	93.4	11.7	1.6	95.8
4039	.0111	4.5	10.8	11	72.5	90--80	93.0	11.1	2.6	94.6
4040	.0108	6.6	10.5	9	71.2	90--80	94.2	11.2	2.0	94.0
4043	.0126	6.4	12.5	5	68.0	120--95	94.2	15.4	2.8	94.8
4050	.0112	15.4	27.9	4	45.1	90--85	94.8	16.6	1.8	95.2
4052	.0120	13.6	25.4	9	48.1	85--75	94.5	18.6	3.1	93.4
4060	.0069	11.1	14.2	3	67.5	95--80	93.0	8.3	2.1	94.9
4062	.0101	6.1	7.7	8	75.3	95--80	93.4	10.1	2.5	95.2
4065	.0083	4.8	12.0	7	74.1	90--80	94.5	11.1	2.7	95.5
4067	.0076	10.3	13.8	1	68.5	115--95	93.4	8.6	3.0	95.2
4068	.0131	6.9	10.5	14	68.1	90--85	94.8	10.0	2.7	95.7
4069	.0078	8.2	17.9	2	65.9	85--75	93.4	10.4	2.8	95.2
4071	.0127	10.7	11.8	12	63.6	100-95	93.1	13.0	2.9	95.8
4073	.0180	9.5	11.3	4	60.8	95--85	93.8	16.6	2.6	96.0
4074	.0155	10.2	18.0	5	55.8	90--80	92.6	18.5	2.3	95.8
4075	.0047	5.9	6.5	1	82.8	95--75	93.8	5.1	2.7	95.4
4076	.0109	7.8	6.2	6	74.5	90--80	94.8	12.2	2.5	95.7
4077	.0085	2.0	5.7	8	83.0	90--75	93.9	10.0	2.8	95.1
4078	.0094	5.7	5.7	8	78.4	95--80	94.7	10.9	2.7	94.9
4081	.0085	6.1	9.5	7	75.2	90--80	94.8	10.6	3.1	95.2
4083	.0074	10.5	12.3	6	69.2	120--85	92.6	9.1	3.1	95.8
4084	.0076	8.5	13.7	0	70.2	130--85	94.0	9.9	3.2	95.8
*4085	.0253	12.0	16.0	6	46.1	90--85	92.6	19.6	2.1	95.8
*4087	.0118	2.3	8.3	1	77.5	85--70	93.2	12.3	1.8	95.5
Average	0.01059	8.52	14.99	6.3	65.27	95--83	93.04	12.73	2.62	95.35
1939 Avg.	0.01152	8.37	16.30	7.3	63.08	100--86	91.57	12.61	1.64	96.37

* Not included in averages

TABLE 9

MINERAL COMPONENTS AND SALT COMPOSITION NON-STEFFENS

Sample Number	Analyses on Sugar Basis									Salt Composition			
	% on Sugar 1/			parts per million						% total salts			
	Carb. Ash	Sulp. Ash	Total Salts	SO_2	SO_3	Cl	Org. 2/	CaO	SiO_2 3/	K_2SO_3	K_2SO_4	KCl	K Org.
4002	0.0072	0.0093	0.0102	4	22	1	27	1	6	9.7	47.0	2.1	43.7
4005	.0082	.0103	.0112	4	17	11	27	3	8	8.8	33.0	20.5	39.8
4006	.0093	.0121	.0139	2	11	10	55	5	5	3.6	17.2	15.1	65.3
4009	.0082	.0098	.0100	15	13	9	7	1	3	37.0	28.3	18.9	11.6
4013	.0098	.0126	.0134	14	17	2	24	4	1	25.8	27.6	3.1	30.0
4014	.0107	.0134	.0144	14	13	12	31	2	7	24.0	19.7	17.4	35.5
4015	.0104	.0132	.0148	10	17	2	48	3	6	16.7	25.0	2.8	53.5
4021	.0114	.0156	.0167	7	29	15	34	8	2	10.3	37.8	18.9	33.6
4022	.0080	.0107	.0119	5	18	1	36	2	5	10.3	32.9	1.8	49.9
4023	.0076	.0101	.0101	10	16	22	0	2	2	24.7	34.6	45.5	0
4028	.0089	.0122	.0123	25	20	5	3	1	9	50.2	35.4	8.5	4.0
4031	.0072	.0090	.0091	5	22	9	2	2	6	13.5	52.6	20.7	3.6
4033	.0069	.0090	.0104	1	14	0	42	6	2	2.4	29.3	0	66.6
4034	.0107	.0147	.0168	3	20	5	63	9	11	4.4	25.8	6.2	61.9
4037	.0086	.0107	.0108	11	21	13	2	1	2	25.2	42.3	25.3	3.0
4038	.0109	.0130	.0136	10	27	11	17	1	15	18.1	43.2	16.9	20.6
4041	.0157	.0200	.0235	3	20	0	106	5	0	3.1	18.5	0	74.5
4042	.0097	.0124	.0124	23	25	2	0	1	3	46.0	43.5	3.2	0
4044	.0073	.0095	.0096	10	24	6	2	1	10	25.7	54.3	13.1	3.4
4045	.0096	.0113	.0123	2	21	11	30	2	10	4.0	38.1	18.6	40.2
4046	.0077	.0092	.0099	2	20	10	22	2	10	4.9	43.6	21.2	36.5
4047	.0134	.0164	.0167	24	28	16	10	2	13	35.5	36.5	20.1	9.8
4048	.0078	.0097	.0108	2	21	7	34	3	11	4.6	42.3	13.6	51.9
4049	.0090	.0113	.0120	5	22	2	21	5	0	10.2	39.9	3.5	28.8
4051	.0147	.0190	.0200	25	17	19	30	3	0	30.9	18.5	20.0	24.7
4053	.0071	.0086	.0091	7	10	3	16	3	6	19.0	27.1	6.9	29.0
4054	.0084	.0105	.0120	4	10	2	45	4	4	8.2	18.1	3.5	61.8
4055	.0096	.0120	.0124	15	10	13	13	2	7	29.8	19.9	22.0	17.3
4056	.0177	.0229	.0261	7	17	9	97	4	12	6.6	14.2	7.2	61.3
4057	.0081	.0101	.0117	5	8	1	48	1	10	10.5	14.8	1.7	67.6
4058	.0095	.0119	.0130	6	11	12	34	3	2	11.3	18.3	19.2	43.1
4059	.0131	.0164	.0190	9	20	2	78	3	9	11.6	22.8	2.2	67.7
4061	.0086	.0111	.0125	5	13	1	43	3	5	9.8	22.6	1.6	56.7
4063	.0058	.0075	.0086	2	11	3	33	7	10	5.7	27.7	7.3	63.3
4064	.0066	.0088	.0092	7	17	6	12	1	9	18.8	40.2	13.6	21.5
4066	.0095	.0121	.0133	13	20	2	37	1	15	24.1	32.7	3.1	45.9
4070	.0101	.0129	.0137	14	23	3	24	1	11	25.2	36.5	4.5	28.9
4072	.0073	.0094	.0099	7	17	1	15	12	7	17.4	37.3	2.2	24.9
4079	.0071	.0087	.0089	12	16	7	7	0	3	33.3	39.1	16.5	12.9
4080	.0057	.0070	.0076	4	16	1	18	1	2	13.0	45.7	2.7	39.0
4082	.0083	.0106	.0114	6	20	6	25	3	2	12.9	38.1	11.0	36.1
4086	.0111	.0132	.0140	6	29	4	25	4	7	10.5	45.1	6.0	29.4
Avg.	0.0093	0.0119	0.0129	8.7	18.2	6.6	30	3.1	6.4	16.6	30.7	10.7	38.3
1939Avg.	.0106	---	---	12.0	8.8	7.1	--	9.8	--	---	---	---	---

1/ Total salts estimated on basis of sulphated ash and calculated organic acids.
2/ Organic acid radicals (combined) estimated from corrected ash alkalinity, arbitrarily assuming a value of 60 as combining weight of the acid.
3/ Acid insoluble material of crude silica.

TABLE 10

MINERAL COMPONENTS AND SALT COMPOSITION -- STEFFENS

Sample Number	Analyses on Sugar Basis									Salt Composition			
	% on sugar 1/			parts per million						% total salts			
	Carb. Ash	Sulp. Ash	Total Salts	SO_2	SO_3	Cl	Org. 1/	CaO	SiO_2 1/	K_2SO_3	K_2SO_4	KCl	K Org.
4001	0.0110	0.0144	0.0162	10	20	3	54	11	8	15.2	26.8	3.8	55.0
4003	.0114	.0143	.0166	4	24	9	70	6	7	5.9	31.4	11.4	69.5
4004	.0091	.0122	.0137	5	18	5	45	5	6	8.9	28.6	7.6	54.2
4007	.0121	.0153	.0172	4	21	11	57	5	8	5.7	26.5	13.3	54.6
4008	.0106	.0132	.0144	9	19	10	36	3	5	15.4	28.7	14.5	41.2
4010	.0093	.0122	.0142	4	12	2	60	4	3	6.9	18.4	2.9	69.7
4011	.0080	.0105	.0122	5	9	0	51	4	5	10.1	16.0	0	68.9
4012	.0082	.0107	.0123	5	13	0	47	4	4	10.0	22.1	0	63.1
4016	.0179	.0231	.0243	20	29	29	37	2	9	20.3	25.9	25.1	25.1
4017	.0114	.0147	.0174	2	15	0	81	8	13	2.8	18.7	0	76.8
4018	.0072	.0097	.0107	8	16	1	30	2	7	18.5	32.5	1.9	46.2
4019	.0110	.0128	.0138	9	17	11	31	4	10	16.1	26.8	16.6	37.0
4020	.0114	.0143	.0170	5	16	1	70	3	6	6.0	20.4	1.2	67.9
4024	.0128	.0166	.0187	7	20	7	64	4	4	9.2	23.2	7.8	56.4
4025	.0090	.0110	.0121	3	20	2	33	3	7	6.1	35.9	5.2	45.0
4026	.0104	.0139	.0155	10	19	4	48	3	8	15.9	26.6	5.4	51.0
4027	.0163	.0213	.0251	8	22	3	114	3	7	7.8	19.0	2.5	74.9
4029	.0110	.0142	.0156	3	22	1	43	3	7	4.7	30.7	3.1	45.4
4030	.0095	.0128	.0137	8	17	9	28	1	9	14.4	27.0	13.7	33.7
4032	.0068	.0093	.0102	3	15	0	27	4	7	7.2	32.0	0	43.6
4035	.0155	.0193	.0224	10	16	6	93	2	2	11.0	15.5	5.6	68.5
4036	.0108	.0133	.0145	4	20	11	36	3	2	6.8	30.0	15.8	40.9
4039	.0111	.0143	.0155	11	23	12	36	1	19	17.5	32.3	16.1	38.3
4040	.0108	.0138	.0153	9	23	4	45	1	9	14.5	32.7	5.4	48.5
4043	.0126	.0164	.0174	5	28	18	30	1	0	7.0	39.6	21.7	28.4
4050	.0112	.0145	.0163	4	17	10	55	7	0	6.0	22.6	12.8	55.6
4052	.0120	.0168	.0194	9	9	3	78	4	0	11.4	10.0	3.2	66.3
4060	.0069	.0088	.0101	3	10	1	39	4	5	7.3	21.6	2.0	63.7
4062	.0101	.0137	.0146	8	24	12	28	0	11	13.5	35.7	17.1	31.6
4065	.0083	.0110	.0127	7	16	1	52	2	14	13.6	27.4	1.6	67.5
4067	.0076	.0098	.0115	1	16	0	51	6	16	2.1	30.2	0	73.1
4068	.0131	.0164	.0181	14	20	15	51	2	19	19.1	24.0	17.4	46.4
4069	.0078	.0095	.0101	2	13	11	18	4	12	4.9	27.8	22.5	29.4
4071	.0127	.0165	.0178	12	20	16	39	4	8	16.6	24.4	18.8	36.1
4073	.0180	.0230	.0258	4	23	28	84	7	22	3.8	19.4	22.7	53.7
4074	.0155	.0191	.0225	5	26	0	103	4	14	5.4	25.1	0	75.5
4075	.0047	.0065	.0078	1	8	1	40	3	16	3.2	22.5	2.6	86.8
4076	.0109	.0132	.0154	6	19	0	67	3	15	9.6	26.8	0	71.8
4077	.0085	.0106	.0115	8	16	8	27	0	2	17.1	30.2	14.6	38.7
4078	.0094	.0109	.0117	8	21	11	24	0	4	16.8	39.0	19.6	33.8
4081	.0085	.0107	.0118	7	16	1	34	4	2	14.6	29.5	1.7	47.5
4083	.0074	.0093	.0100	6	17	0	21	6	1	14.8	37.0	0	34.6
4084	.0076	.0097	.0108	0	21	5	34	5	4	0	42.3	9.7	51.9
*4085	.0253	.0330	.0375	6	40	28	135	12	11	3.9	23.2	15.6	59.4
*4087	.0118	.0146	.0172	1	27	0	77	4	7	1.4	34.1	0	73.8
Avg.	0.0106	0.0136	0.0152	6.3	18.3	6.6	49	3.6	7.8	10.2	26.2	9.1	53.6
1939 Avg.	.0115	--	--	7.3	10.5	7.7	--	10.4	--	--	--	--	--

* Not included in averages
1/ See notes bottom table 9

Carbonate ash values average about 22% below the fully sulphated ash. As in the case of most other sugar products the arbitrary 10% or 15% deduction, by which it is customary to estimate carbonate ash from sulphate ash, is found to be too low a correction. On individual sugars the factors for correlating carbonate and sulphate ash are quite variable as they are in part dependent on the proportion of fixed minerals such as sulphates to the mineral-organic salts which are weighed as oxides or carbonates. Sulphated ash can be somewhat more accurately determined as all bases are then weighed as sulphates; in the carbonate ash the weights observed are affected by variable volatilization losses of chlorine and variable decomposition losses of sulphates, sulphites and carbonates.

Sugar Color

The lower ash content of the 1940 sugars was not accompanied by an improvement in the color of the sugars in solution as has usually been the case. In fact the non-Steffens sugars averaged about a third higher in solution color than in 1939. The increase in the Steffens sugar color average was not significant. The increases were not due to an unusual number of sugars with high color but rather to small increases in the color of sugars which in 1939 gave very low color values; in short the trend was to a more uniform sugar color. In 1939 about a third of the sugars had color index below 5.0; in the present year only about 20% were in this very low range. In 1939 the top 10% of the sugars averaged 16.4 color index as against 14.9 for the top 10% this year, indicating an improvement in the color of those sugars in the high color group. This was more than offset, so far as averages are concerned, by the increases in color of the extremely low color group. The low 10% in 1939 averaged 1.6 color index as compared with 3.0 for the low group in 1940. These facts confirm the statement that there was an improvement

in the uniformity of color even if not in the average color.

There is little doubt but that certain types of turbidity very much affect the estimation of the color index by the present procedure. It is believed that this turbidity error in the color reading accounts for some of the apparently high sugar colors, and perhaps of some of the high candy colors. A study will be made next season comparing the present method of determination of color in solution with one employing filtration for separation of the turbidity factor.

Turbidity

The 1940 averages for turbidity slightly increased over 1939 for the non-Steffens sugars and decreased a like amount in the Steffens sugars to obtain a general average that is essentially unchanged but still high as compared with 1938 results.

Sulphites

The downward trend in sulphite content of the sugars continued. As sulphite content is a factor in sugar color it is probable that the especially low value for sulphites in non-Steffens sugars may partly account for the observed apparent increase in color.

Formula Ratings

The formula ratings are based on color and turbidity in solution, the ash and the sulphite content, using the same formula calculations as described in the 1939 report. An improvement is seen in the case of Steffens factories while the average for the non-Steffens was essentially unchanged. The highest and the lowest rating sugars are both in the Steffens group. It has been suggested that the generally low values given by the present method of calculating formula ratings might be misleading to anyone unfamiliar with what they represent -- in brief,

that a sugar with a 65 rating might be considered as only 65% as good as it could be. Actually, it is merely a means of giving an arbitrary value for a group of quality factors for comparative purposes without any attempt even at balancing these factors in order of importance. It is desirable that any scheme of evaluating sugar quality should greatly exaggerate small, but sometimes important, differences which actually exist, in order that changes in quality may be fully apparent. It seems logical that a formula rating, however derived, might be put on a percentage basis by comparing the rating observed with the rating shown by what might be called a perfect or standard sugar. Since it is not anticipated that an absolutely ashless, colorless sugar can be produced commercially there may be some merit in selecting obtainable values for each quality factor in order to arrive at a formula rating for the model sugar. The observed formula rating divided by this standard formula rating and multiplied by 100 will give a percentage value indicating how closely the individual sugar comes to the ideal. This method has the advantage that changes in the method of calculating a formula value, or the addition of other factors in its calculation, could be made without greatly affecting its relationship to the standard.

Without trying to select the very lowest values which have been obtained at one time or another, the following analytical values will be tentatively adopted as representing a suitable standard.

Ash (carbonate) 0.0050, Color index 3.0
SO_2 0.0005, Turbidity index 6.5

This gives a formula rating, as at present calculated, of 85. Just as an example of how this would alter the rating values of the sugars some comparative values follow:

Formula Rating	Percentage of Standard
45	52.9
65	76.5
80	94.1

With a formula rating of 85 as standard it is probable that an occasional sugar will exceed 100% of the standard but if the general purpose of this calculation is to be realized it is necessary to adopt a standard that is attainable. It seems desirable that such an arbitrary evaluation of quality factors should include reflectance, foaming and candy color, and an effort will be made to bring these factors into the picture.

Other Tests

The foaming tests, on the average, showed an improvement over 1939. Further improvement was also found in the reflectance measurements which surpassed the values obtained in any year to date. With only one reading below 90 as compared with twelve in 1936, the improvement in sugar appearance is very marked and sets a high standard. The invert sugar in the barley candy tests has tended to increase ever since 1935. It is possibly partly due to the decreasing ash content producing a less buffered condition and therefore a more unstable pH. The 1940 results show a marked increase in reducing sugars and decrease in sucrose.

From tables 9 and 10 it is seen that the sulphate content (SO_3) shows a marked increase. Analytical methods were closely checked without finding any error to account for this change. Chlorides (Cl) were found to have decreased and lime (CaO) content showed a marked drop to a value below that of any previous year. An effort was made this year to determine silica gravimetrically. Because of the small quantities involved the estimation is only approximate and in any case is just the crude silica as vaporization with hydrofluoric acid was not used. The

average value for a number of samples no doubt gives a fairly accurate picture of the amounts of acid insoluble material remaining in the sugars. In 1932 and 1933 when silica was estimated colorimetrically the value obtained averaged about 15 parts per million as contrasted with the present average of about 7 parts. This is the type of comparison that would be expected from the general improvement in the sugars.

Total Salts

In tables 9 and 10 is also introduced the concept of total salts as a measure of sugar purity. The usual carbonate ash determination gives an approximation of mineral constituents but fails to give the proper idea as to the salt content which bears a variable relation to the ash content and is much greater in amount. Sulphated ash comes closer to the value for salt content and is used as the basis of salt estimations. The calculation of the combined organic acid radicals is based on ash alkalinity determinations corrected for initial chloride, sulphate and sulphite content. Instead of stating this corrected ash alkalinity as stoichiometrically equivalent to so much basicity, it seems desirable to give it a more tangible form which can be directly compared with the values for Cl, SO_3, etc. Therefore, the alkalinity is calculated arbitrarily to the equivalent amount of an organic acid radical with a combining weight of 60. This combining weight of 60 is about the average of the combining weights of the common organic acids such as oxalic, acetic, tartartic, etc., but is low compared with the nitrogen acids. The values shown using the 60 factor are therefore probably lower than the true weights of the combined organic acid radicals present in sugar products. One third of the weight of the organic acid radical estimated

is added to the sulphated ash in approximating the quantity of total salts. (This factor of one third represents the difference in weight between the SO_3 radical and the organic radical.) On the average the estimated salt content of non-Steffens sugars was 8.0% greater than the sulphated ash, and for Steffens sugars it was 12% higher. Viewed differently on the average the carbonate ash of non-Steffens sugars was 28% below the content of salts and for the Steffens sugars the carbonate ash was 30% below the salt content. Individual sugars varied widely in their content of combined organic acids and therefore in the differences between carbonate ash and salt values.

Finally the mineral and organic acid radicals were calculated to their equivalent potassium salts and an approximate salt composition is presented on this basis. Since sodium, calcium and perhaps magnesium are also present, not all the salts are actually potassium compounds, so it is not to be expected that the percentage composition given would total up to exactly 100%. On individual analyses the total is in some instances over 100% and in others too low but the totals of the averages, namely, 96.3% and 99.1%, indicate that the approximations are reasonable and in general give a fair picture of the salt composition. It is repeated that the values for estimated salts are still probably minimum values as it is likely that the combined organic acids are more complex and of higher combining weight than assumed in these calculations.

An examination of the results shows that in many instances high ash in sugar is due to high content of organic salts. The general tendency for Steffens sugars to be higher in ash than non-Steffens is apparently due to this fact. Note in the averages for constituents that the combined organic acids furnish the only marked contrast between Steffens

and non-Steffens sugars and in the salt composition that the organic salts are 53% of the total in the Steffens sugars and only 38% in the non-Steffens. These observations regarding the organic salt contents of sugars are in no known way associated with the quality of the sugars from the viewpoint of their use but may be of advantage in leading to a better understanding of the nature of the non-sugars present. It is of interest that equal amounts of ash may be the residues from quite different quantities of salts; for example, in one instance a sugar ash of 0.0076 was derived from a salt content of only 0.0101 while in another case this same amount of ash was derived from a salt content of 0.0115.

Sugar and Candy pH

Considering now the data presented in tables 11 and 12 on the pH values of sugar and barley candy solutions it will be noted that a start has been made in the use of the glass electrode pH meter in place of the colorimetric tube method. It has long been difficult to understand why the pH of the sugars should be so uniform as previously found. This appears to have been due partly to the concentration of the sugar solution tested and partly to the colorimetric method used. On the regular samples the colorimetric reaction on solutions of 15 grams of sugar per 100cc ranged from pH 6.8 to 7.3 but on the 30 grams per 100cc concentration the range was from pH 6.5 to 7.4. The pH meter in the first instances gave values from pH 6.5 to 7.25 and at the higher concentration values ranged from pH 6.05 to 7.5. The averages by the two methods are not greatly different. Individually some sugars increased in pH at the higher concentration; in others the pH dropped and the averages both colorimetrically and electrometrically were lower at the higher concentration. Examining the data with regard to the pH of the white pans it is found that there is a general relationship as seen in the following summary of

TABLE 11

pH and Conductivity Values
Non-Steffens

Sample Number	pH of Sugars(different concentrations) 15 g. 100cc Color.	15 g. 100cc Electro.	30 g. 100cc Color.	30 g. 100cc Electro.	pH Candies 30 g (100cc) Color.	Electro.	Conductivity Factors Carb.Ash	Sulp. Ash
4002	7.3	7.2	7.0	7.15	4.3	4.1	280	217
4005	7.3	7.25	7.0	6.9	4.4	4.15	294	235
4006	7.3	7.1	7.2	6.95	4.3	4.2	280	215
4009	6.8	6.9	6.6	6.55	4.3	4.05	271	226
4013	6.9	6.7	6.6	6.65	4.0	4.05	224	175
4014	6.9	6.8	6.6	6.7	4.0	4.05	256	204
4015	6.9	6.7	6.6	6.6	4.1	4.1	257	202
4021	7.2	7.1	7.0	7.1	4.3	4.25	289	211
4022	7.3	7.1	7.2	7.45	4.2	4.15	284	212
4023	7.0	7.05	6.8	6.9	4.4	4.4	292	220
4028	6.8	6.85	6.5	6.55	4.3	4.3	284	207
4031	7.2	7.1	7.1	7.25	4.1	4.0	292	233
4033	7.1	7.0	7.0	6.85	4.5	4.8	270	207
4034	7.3	7.05	7.3	7.4	4.2	4.25	255	186
4037	7.2	7.15	6.7	6.85	4.2	4.0	323	260
4038	7.1	7.1	6.9	6.95	4.2	4.15	266	223
4041	7.4	7.3	7.4	7.5	4.1	4.25	257	202
4042	6.9	7.15	6.7	6.65	4.1	4.05	287	224
4044	7.0	7.25	6.8	6.9	4.4	4.35	275	211
4045	7.3	7.4	7.3	7.4	4.2	4.1	234	199
4046	7.2	7.2	7.0	7.1	4.3	4.25	257	215
4047	6.8	6.75	6.5	6.5	4.0	4.0	251	205
4048	7.3	7.3	7.1	7.0	4.2	4.15	272	219
4049	7.1	7.1	6.9	6.8	4.1	4.15	236	188
4051	6.8	6.75	6.5	6.45	4.1	4.1	265	205
4053	7.0	6.8	6.6	6.5	4.2	4.05	252	208
4054	7.1	6.8	6.8	6.5	4.4	4.35	240	192
4055	6.8	6.7	6.6	6.65	4.1	4.0	268	214
4056	7.1	6.7	7.3	7.25	4.4	4.4	233	180
4057	7.2	6.95	7.2	7.5	4.3	4.2	247	198
4058	7.0	6.8	7.0	7.15	4.4	4.4	248	198
4059	7.1	6.8	7.0	7.15	4.3	4.25	250	200
4061	7.2	6.95	7.2	7.15	4.2	4.1	269	208
4063	7.3	6.75	7.1	7.1	4.2	4.1	259	200
4064	7.0	6.7	6.9	7.0	4.2	4.05	250	188
4066	6.9	6.9	7.0	7.05	4.3	4.1	260	204
4070	6.9	6.65	6.7	7.0	4.3	4.25	274	215
4072	6.9	6.6	6.6	6.6	4.1	4.15	219	172
4079	6.8	6.55	6.7	6.3	4.3	4.2	286	233
4080	7.1	6.7	6.9	6.25	4.3	4.2	256	208
4082	7.1	7.1	7.0	6.5	4.2	4.15	267	209
4086	7.2	7.15	7.0	6.55	4.3	4.25	246	207
Average -	7.08	6.95	6.90	6.89	4.23	4.18	264	208
1939 Avg.	6.99	--	--	--	4.78	--	--	--

TABLE 12

pH and Conductivity Values
Steffens

Sample Number	pH of Sugars(different concentrations) 15 g.100cc		30 g 100cc		pH Candies 30g 100cc		Conductivity Factors Carb.Ash	Sulp.Ash
	Color.	Electro.	Color.	Electro.	Color.	Electro.		
4001	7.2	7.1	7.0	6.85	4.5	4.4	262	200
4003	7.1	7.0	6.7	6.6	4.4	4.3	253	201
4004	7.1	7.0	6.8	6.65	4.5	4.5	259	193
4007	7.1	7.15	7.0	7.0	4.3	4.15	269	212
4008	7.1	7.2	6.8	6.95	4.2	4.15	264	212
4010	7.0	6.65	6.4	6.05	4.1	4.3	247	189
4011	7.1	6.7	6.7	6.35	4.5	4.55	240	183
4012	7.1	6.75	6.8	6.65	4.0	4.1	244	189
4016	6.8	6.6	6.5	6.4	4.1	4.25	259	200
4017	6.9	6.5	6.8	6.4	4.2	4.25	257	200
4018	6.9	6.65	6.9	6.75	4.2	4.2	281	208
4019	6.9	6.6	6.6	6.6	4.3	4.25	240	206
4020	7.3	7.2	7.2	7.25	4.3	4.25	248	198
4024	7.3	7.1	7.1	7.05	4.3	4.3	255	197
4025	7.1	6.9	7.0	6.8	4.5	4.75	244	200
4026	6.9	6.8	6.7	6.65	4.0	4.15	260	194
4027	7.3	7.2	7.3	7.35	4.1	4.35	267	204
4029	7.3	7.05	7.1	6.9	4.4	4.45	269	208
4030	6.9	6.9	6.8	6.8	4.3	4.35	295	219
4032	7.0	6.8	6.8	6.65	4.2	4.2	247	181
4035	6.9	7.0	6.7	6.55	4.3	4.3	254	204
4036	7.1	7.25	7.1	7.0	4.2	4.1	256	208
4039	7.1	7.0	6.7	6.75	4.4	4.4	263	204
4040	7.1	7.0	6.9	6.9	4.2	4.1	237	186
4043	7.3	7.35	7.4	7.5	4.0	4.25	289	222
4050	6.9	6.85	6.6	6.45	4.3	4.2	254	197
4052	7.0	6.75	6.8	6.5	4.3	4.2	258	188
4060	7.1	6.7	6.9	6.85	4.5	4.45	230	181
4062	7.0	6.7	6.9	7.0	4.1	4.0	277	204
4065	7.0	6.7	7.0	7.05	4.2	4.05	244	185
4067	7.1	6.65	7.0	6.85	4.3	4.3	224	173
4068	6.9	6.5	6.8	6.8	4.3	4.2	255	204
4069	7.3	6.75	7.2	7.1	4.3	4.2	278	228
4071	6.9	6.5	6.7	6.8	4.1	4.2	271	208
4073	7.2	6.5	7.1	7.0	4.3	4.3	271	212
4074	7.3	6.8	7.3	7.1	4.3	4.35	254	206
4075	7.1	6.95	7.1	7.05	4.3	4.15	285	206
4076	6.9	6.65	6.8	6.5	4.2	4.2	239	197
4077	6.9	6.65	6.8	6.4	4.3	4.25	265	212
4078	6.8	6.75	6.8	6.35	4.3	4.2	262	226
4081	7.0	6.75	6.7	6.65	4.2	4.15	253	201
4083	7.0	6.7	6.6	6.2	4.3	4.3	234	186
4084	6.9	6.55	6.5	6.3	4.3	4.25	247	194
*4085	7.1	6.75	6.9	6.4	4.4	4.45	245	188
*4087	7.5	7.6	7.5	7.5	4.4	4.25	272	230
Average -	7.05	6.83	6.87	6.75	4.27	4.26	257	201
1939 Avg.	6.99	--	--	--	4.76	--	--	--

* Not included in the averages

electrometric values:

White Pan pH	Average pH of Sugar Solutions (30 g per 100cc)
8.8-9.2	7.2
8.4-8.8	6.9
8.0-8.4	6.7
7.6-8.0	6.5
7.0-7.6	6.3

A few of the individual results did not follow this trend but the general relationship was very pronounced. In the future only the glass electrode pH meter will be used for these measurements and the sugar solutions will be of the 30 grams per 100cc concentration.

In the case of the pH measurements on solutions of the barley candies the agreement between colorimetric and electrometric methods is excellent. The concentration of 30 grams per 100cc solution was used and accounts for the general results being slightly lower than in previous years. The results do not appear to be correlated with sugar pH, ash or salt composition.

Conductivity Ash

The use of conductivity methods for the estimation of sugar ash have been in common use in the beet sugar industry for years. As had been pointed out by many workers the first prerequisite is the accurate determination of the carbonate or sulphated ash that is used as the basis of reference in establishing the proper relationship between specific conductivity and ash. It is recognized that the correlation factor of specific conductivity and ash varies with the salt composition as well as with the quantities of total salts or of ash because of the differing conductivity of the various ions involved. Hence, since the composition of the salts in beet sugars is variable, no constant factor is possible no matter how accurate the ash determination. It has seemed desirable

to add a little to the information that has been accumulated in the industry by some studies of the conductivity ash factors on these annual sugar samples, representing as they do considerable variation in the quantity and composition of ash.

Specific conductance was measured with a Leeds and Northrup ash bridge at a temperature of 20°C and a sugar concentration of 30 grams in 100cc of solution (using low conductivity water). On an initial set of twelve sugars, representing the extremes of ash and salt composition, specific conductance determinations were made at concentrations of 10, 15, 20, 25, 30, 35, 40 and 60 grams of sugar made up to 100cc. The highest specific conductivity was found at the 30 gram concentration in all cases but the 25 and 35 gram readings were not greatly different so no particular accuracy in making up the solutions is justified. In 1927, A. R. Nees recommended a 25 gram concentration. Our results confirm the fact that conductivity on 25 grams is usually higher than that on 35 grams but 30 grams gave the maximum values. Whether temperature has any effect in displacing this maximum point has not been tried but it should be kept in mind that the results for this report were determined at 20°C rather than 25°C or higher, as is more commonly done in the factory. This temperature was selected because of the availability of a constant temperature room at this condition.

The calculated specific conductivity-ash factors are shown in tables 11 and 12. Both carbonate and sulphated ash factors are given. Statistically the sulphated ash values show a somewhat smaller variability. In spite of the care in determining and duplicating the ash values it is still felt that some of the extreme conductance-ash factors are probably

partly due to incorrect ash values, but more exhaustive studies were not possible at present. There is unquestionably a tendency for the factors to be lower for Steffens than for non-Steffens factories of a given locality. Further there is indication that high proportions of organic salts may tend to yield low factors. The regional effects can best be seen from the averages presented in tables 15 and 16 which will be considered later.

Screening Tests

Now examining the screening tests reported in tables 13 and 14 it may be noted that as usual the sugars show excellent uniformity, that is, a large proportion of each sugar is within a narrow range of grain size. This range is somewhat different in the case of different sugars but for the great majority of sugars the proportion passing screen number 30 and retained on number 50 is large, as much as 83.8% for one sugar. On the average the sugars tended to be slightly coarser than in 1939 showing a larger percentage in the 30-50 size and a smaller proportion of fines passing number 80. On the basis suggested in the 1939 report, that is, considering the total sugar retained in screens 40, 50 and 60 as an indication of grain regularity, the sugars of 1940 show the highest rating of any year to date. The average total is 81.5 and may partly account for the exceptionally high reflectance tests.

An effort was made to find a uniform basis for classifying sugars in respect to size of grain. The values under the heading of summary are given for this purpose.

TABLE 13

Screening Tests--Comparison of Grain Size
Non-Steffens

Sample	Percent retained on Screens U.S.No.								Thru	Summary			
Number	20	30	40	50	60	70	80	100	100	on 30	thru 30 on 50	thru 80	class no.
4002	0	0.3	14.4	38.5	13.3	13.6	7.4	8.0	4.5	0.3	52.9	12.5	F
4005	0	0.1	12.7	50.1	11.5	10.5	6.0	5.5	3.6	0.1	62.8	9.1	M
4006	0	1.0	24.0	42.3	10.3	9.2	5.7	4.9	2.6	1.0	66.3	7.5	M
4009	0	0.2	22.0	46.5	8.9	9.0	5.3	4.8	3.3	0.2	68.5	8.1	M
4013	0	1.1	35.7	38.6	9.1	6.0	3.5	3.3	2.7	1.1	74.3	6.0	M
4014	0	0.3	24.9	4.17	8.7	8.5	5.1	6.3	4.5	0.3	66.6	10.8	FM
4015	0	1.7	38.0	35.3	9.2	6.9	3.9	3.2	1.8	1.7	73.3	5.0	M
4021	0	0.2	12.6	36.0	11.4	14.6	7.2	9.6	8.4	0.2	48.6	18.0	F
4022	0	1.4	21.8	36.2	11.2	12.0	5.4	7.5	4.5	1.4	58.0	12.0	F
4023	0	0.5	35.4	35.4	8.1	7.5	5.2	4.8	3.1	0.5	70.8	7.9	M
4028	0	3.0	41.4	27.7	8.8	7.4	4.6	4.3	2.8	3.0	73.6	7.1	MC
4031	0	0.4	44.2	38.8	6.6	4.2	2.3	2.2	1.3	0.4	83.0	3.5	MC
4033	0	0.4	38.0	38.4	8.2	6.4	3.5	3.1	2.0	0.4	76.4	5.1	M
4034	0	1.4	29.9	37.9	9.2	9.3	4.5	4.9	2.9	1.4	67.8	7.8	M
4037	0	1.0	47.4	34.7	5.9	5.2	2.6	2.2	1.0	1.0	82.1	3.2	MC
4038	0	0.6	31.0	33.6	9.1	9.6	4.7	6.2	5.2	0.6	64.6	11.4	FM
4041	0	0.2	40.8	40.6	7.2	5.4	2.6	2.0	1.2	0.2	81.4	3.2	MC
4042	0	0.4	30.0	44.0	8.7	7.4	3.8	3.5	2.2	0.4	74.0	5.7	M
4044	0	1.4	54.6	23.0	6.4	4.2	2.2	1.8	1.4	1.4	82.6	3.2	MC
4045	0	1.6	56.4	28.0	6.2	3.4	2.0	1.6	0.8	1.6	84.4	2.4	MC
4046	0	2.2	47.6	30.7	7.5	4.9	2.9	2.7	1.5	2.2	78.3	4.2	MC
4047	0	0.1	39.8	39.7	7.8	5.2	3.4	2.6	1.4	0.1	79.5	4.0	M
4048	0	0.3	39.0	37.0	8.4	7.3	3.6	2.9	1.5	0.3	76.0	4.4	M
4049	0	14.2	52.6	19.4	5.5	3.6	2.2	1.7	0.8	14.2	72.0	2.5	C
4051	0	0.9	43.3	36.3	5.9	5.2	3.1	3.1	2.2	0.9	79.6	5.3	MC
4053	0	0.6	20.8	45.0	11.8	10.4	4.2	4.0	3.2	0.6	65.8	7.2	M
4054	0	1.0	37.2	34.6	8.5	7.2	4.7	4.3	2.5	1.0	71.8	6.8	M
4055	0	0.0	4.4	47.5	15.3	14.1	7.4	7.4	3.9	0.0	51.9	11.3	F
4056	0.8	11.7	35.7	30.9	7.9	6.0	3.3	2.6	1.1	12.5	66.6	3.7	C
4057	0	0.1	19.6	43.6	10.0	10.0	5.9	6.0	4.8	0.1	63.2	10.8	FM
4058	0	0.2	21.7	41.7	8.8	11.4	5.6	6.4	4.2	0.2	63.4	10.6	FM
4059	0.6	13.2	38.0	29.1	6.9	5.4	3.0	2.6	1.2	13.8	67.1	3.8	C
4061	0	3.0	34.4	36.0	8.4	7.8	4.6	3.8	2.0	3.0	70.4	5.8	M
4063	0	0.8	34.8	38.2	9.2	7.3	4.3	3.8	1.6	0.8	73.0	5.4	M
4064	0	0.4	36.2	42.1	7.7	5.9	3.4	2.9	1.4	0.4	78.3	4.3	M
4066	no test												
4070	0	0.2	24.8	36.6	8.5	9.7	5.9	7.0	7.3	0.2	61.4	14.3	FM
4072	0	0.3	26.8	45.9	11.1	7.3	3.7	3.4	1.5	0.3	72.7	4.9	M
4079	0	0.3	34.4	37.6	8.9	7.1	4.4	4.3	3.0	0.3	72.0	7.3	M
4080	0	0.0	21.4	52.2	10.1	7.8	3.8	2.9	1.8	0.0	73.6	4.7	M
4082	0	0.2	35.8	40.0	8.5	6.4	3.9	3.4	1.8	0.2	75.8	5.2	M
4086	0	0.8	26.8	44.0	8.6	8.6	4.6	4.2	2.4	0.8	70.8	6.6	M
Average	0	1.6	32.4	38.1	8.8	7.8	4.3	4.2	2.7	1.6	70.5	6.9	M
1939 Av.	0	1.1	21.8	43.1	11.4	8.7	5.5	5.0	3.3	1.1	64.9	8.3	FM

TABLE 14

Screening Tests--Comparison of Grain Size
Steffens

Sample Number	Percent retained on screens (U.S.No.) 20	30	40	50	60	70	80	100	Thru 100	Summary: on 30	thru 30 on 50	thru 80	class no.
4001	0.1	4.7	36.7	34.8	8.9	6.5	3.8	2.9	1.6	4.8	71.5	4.5	MC
4003	0	0.1	7.7	48.2	15.3	12.2	7.0	5.9	3.6	0.1	55.9	9.5	F
4004	0	0.2	9.9	48.8	11.8	10.3	6.5	6.7	5.8	0.2	58.7	12.5	F
4007	0	0.4	28.2	36.6	11.0	9.2	5.8	5.6	3.2	0.4	64.8	8.8	M
4008	0.1	0.8	28.0	40.2	8.4	8.1	5.4	5.6	3.4	0.9	68.2	9.0	M
4010	0	0.2	24.4	48.4	7.6	8.0	4.4	4.4	2.6	0.2	72.8	7.0	M
4011	0	0.1	32.6	41.5	10.0	7.3	3.8	3.2	1.5	0.1	74.1	4.7	M
4012	0	1.1	54.3	29.5	6.3	4.3	2.5	1.5	0.5	1.1	83.8	2.0	MC
4016	0	0.4	18.8	46.4	9.2	9.8	6.0	6.4	3.0	0.4	65.2	9.4	FM
4017	0	1.0	27.4	37.2	10.0	9.8	5.4	5.8	3.4	1.0	64.6	9.2	FM
4018	0	0	20.8	51.4	10.3	7.1	4.4	3.8	2.2	0	72.2	6.0	FM
4019	0	0	5.4	51.8	12.4	13.0	6.8	6.4	4.2	0	57.2	10.6	F
4020	0	0.1	10.3	43.6	14.1	11.4	7.8	7.8	4.9	0.1	53.9	12.7	F
4024	0	1.0	33.4	40.2	10.2	7.1	3.8	2.7	1.6	1.0	73.6	4.3	M
4025	0	0.4	16.8	47.2	11.6	9.6	5.8	5.0	3.6	0.4	64.0	8.6	M
4026	0	1.4	34.6	34.6	9.4	8.1	4.9	4.4	2.6	1.4	70.2	7.0	M
4027	0	0.2	19.0	36.4	10.0	10.3	6.5	9.4	8.2	0.2	55.4	17.6	F
4029	0	0.8	30.8	37.0	9.8	9.0	5.0	4.6	3.0	0.8	67.8	7.6	M
4030	0	0.2	24.5	44.5	11.1	7.5	4.5	4.6	3.1	0.2	69.0	7.7	M
4032	0	0.3	30.8	38.3	9.9	8.6	4.5	4.4	3.2	0.3	69.1	7.6	M
4035	0	3.0	34.0	35.2	10.6	6.2	4.6	4.0	2.4	3.0	69.2	6.4	M
4036	0	0	24.0	48.8	10.1	7.6	3.9	3.5	2.1	0	72.8	5.6	M
4039	0	0.4	20.8	41.2	10.4	9.6	6.0	6.2	5.4	0.4	62.0	11.6	F
4040	0	0.3	22.8	40.2	9.4	8.2	6.0	6.8	6.3	0.3	63.0	13.1	F
4043	0	1.0	29.6	36.0	10.2	9.2	5.4	5.2	3.4	1.0	65.6	8.6	M
4050	0	0.2	7.9	45.2	13.6	11.0	6.5	7.2	8.4	0.2	53.1	15.6	F
4052	0	0.2	18.0	43.4	11.2	8.8	5.0	5.8	4.6	0.2	64.4	10.4	FM
4060	0	0.6	46.6	36.8	7.0	4.2	2.2	1.8	0.8	0.6	83.4	2.6	MC
4062	0	0.5	36.2	40.2	8.1	5.8	3.5	3.6	2.1	0.5	76.4	5.7	M
4065	0.1	0.5	27.0	47.3	9.5	6.6	3.5	3.1	2.4	0.6	74.3	5.5	M
4067	0	0.3	37.3	39.0	8.0	6.2	3.6	3.4	2.3	0.3	76.3	5.7	M
4068	0	0.2	14.4	51.0	10.4	8.6	5.1	5.3	5.0	0.2	65.4	10.3	FM
4069	0	0.3	26.4	40.9	9.3	9.8	4.4	5.2	3.7	0.3	67.3	8.9	M
4071	0	0	27.4	47.6	9.0	7.0	3.6	3.4	2.0	0	75.0	5.4	M
4073	0	2.6	34.6	36.4	8.3	8.1	4.7	3.6	1.7	2.6	71.0	5.3	M
4074	0	1.6	38.8	34.5	8.1	6.7	4.0	3.7	2.6	1.6	73.3	6.3	M
4075	0	0.2	33.8	41.0	9.3	7.8	4.2	2.6	1.1	0.2	74.8	3.7	M
4076	0	0.4	27.6	36.8	9.2	9.0	6.3	6.4	4.3	0.4	64.4	10.7	FM
4077	0	4.4	56.2	27.4	5.4	3.1	1.8	1.3	0.4	4.4	83.6	1.7	C
4078	0	0.5	43.8	37.2	7.3	5.3	2.6	2.1	1.2	0.5	81.0	3.3	MC
4081	0	0	5.8	52.8	14.2	11.2	6.1	5.3	4.6	0	58.6	9.9	F
4083	0	0.1	32.0	43.4	8.3	7.4	3.8	3.3	1.7	0.1	75.4	5.0	M
4084	0	0.2	44.8	34.1	6.7	6.4	3.6	2.8	1.4	0.2	78.9	4.2	M
*4085	0	0.8	28.0	47.8	8.6	7.4	3.4	2.8	1.2	0.8	75.8	4.0	M
*4087	0.7	7.0	43.2	28.8	7.4	4.6	3.1	2.6	2.6	7.7	72.0	5.2	MC
Average	0	0.7	27.5	41.3	9.8	8.2	4.8	4.6	3.1	0.7	68.8	7.7	M
1939 Avg.	0	0.7	17.7	44.1	12.3	9.3	6.2	5.1	4.1	0.7	61.8	9.2	FM

* Not included in averages

The letters designating classes have the following tentative meaning: F signifies fine; M - medium; C - course; FM - fine medium; and MC - medium coarse. These classifications were assigned on the basis of the totals retained on screens 40 and 50 combined with a consideration of the quantities retained on 30 and the amounts passing number 80.

The tentative distinctions used for the three main divisions were as follows:

C - Coarse	Over 60% passing 30 and retained on 50
	Over 3% retained on 30
	Less than 5% passing 80
M - Medium	Over 60% passing 30 and retained on 50
	Less than 3% retained on 30
	Less than 10% passing 80
F - Fine	Less than 60% passing 30 and retained on 50
	Trace or none retained on 30
	Over 10% passing 80

Some sugars do not fall completely into any one of these classes but it appears that a simplified screening test and classification on this or a similar basis is possible. Examination of the screening tests of former years and also of retail cane sugars indicate that the scheme suggested is workable, and merely needs to be expanded to take in intermediate grades.

SUMMARY OF DATA FOR SELECTED FACTORY GROUPS

In tables 15 and 16 are tabulated the averages for both operating data and sugar analyses for groups of factories which are tentatively averaged together. The grouping was partly on the basis of regional location and partly on similarity of diffusion juice purities; it was also modified in a few instances on the basis of sugar ash characteristics. In brief the objective was to class together factories which seemed to process beets of similar quality characteristics in the hope that a better understanding may be obtained of the problems in the different areas. On

the average, there are some eight factories in each group, four non-Steffens and four Steffens. Some groups are larger and others are smaller than this. The comparative average values for the three years 1937-9 furnish a basis for judging the 1940 values. Many of the trends which have already been discussed, such as the use of less lime and sulphur and the reduction in sugar ash and sulphites, are common to all groups, but other factors do not show such uniform trends. For example, some groups show a better sugar color as compared with the previous three years; others do not. To properly mention or discuss all the points that may be observed in these tables is too lengthy a job to be attempted in this report. However, attention is called to the averages for the amounts of combined organic acid and the estimated percentages of organic salts. The groups are seen to differ widely in these respects; for example, the range of the non-Steffens group averages for the combined organic acid radicals is from 6 p/m to 65 p/m and in the case of Steffens groups from 24 p/m to 72 p/m. The corresponding organic salts, as percent of total salts, range from 11.5% to 58.3% and from 38.4% to 69.8%. Also note that the group averages for the conductance-carbonate ash factor vary from 235 to 279 for the non-Steffens and from 246 to 269 for the Steffens. This agrees with the observation that the proportions of organic salts show greater contrast between the different non-Steffens groups than between the Steffens groups. The corresponding conductance-salt factors range from 173 to 211 and from 161 to 189.

Finally there is some indication of a relationship between the proportion of organic salts and the yeast inoculum multiple determined by H. H. Hall. At least the non-Steffens groups F, H, K and M have high proportions of organic salts and are also highest in yeast growth index.

Similarly the Steffens groups A, B, F and K are high in both determinations. Steffens groups C and M are the only exceptions to this correlation.

RÉSUMÉ

The 1940 sugars show a continuation in the improvement of the uniformity of sugar quality. Ash values are markedly decreased below any previous year and reflectance values are higher. Many other factors also improved, for instance the content of sulphites, chlorides and lime, the foaming tests and the uniformity of grain size. These accomplishments, denoting more uniform and better operating practices, are a credit to the industry.

It is hoped that the extension of the report to include work on sulphated ashes, conductivity factors and ash alkalinity or combined organic acids will prove of interest; also, that the changes in the presentation of the data and the inclusion of group averages will be found satisfactory and helpful.

TABLE 15
SUMMARY OF DATA FOR SELECTED FACTORY GROUPS

NON-STEFFENS

GROUP----	A		B		C		D		E	
	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9
Sucrose, beets	16.6	16.8	15.4	16.6	16.4	16.0	15.2	15.8	14.4	15,5
Juice Purity	88.8	89.2	85.9	86.5	87.6	87.4	87.1	86.9	84.9	84.7
Wht.pan Purity	92.2	92.1	92.0	92.1	91.7	91.2	91.1	90.4	90.9	91.0
Diff.Pur.J&P	3.4	2.9	6.1	5.6	4.1	3.8	4.0	3.5	6.0	6.3
Hi-Green Purity	85.9	85.8	85.2	85.1	85.9	83.9	82.7	81.6	82.4	83.7
Drop in Purity	6.3	6.3	6.8	7.0	5.8	7.3	8.4	8.8	8.5	7.3
Lime used	1.88	2.02	1.92	2.32	2.45	2.17	1.26	1.49	1.65	2.23
Soda ash used	0.03	0.02	0.13	0.05	0.37	0.02	0.17	0.21	0.26	0.00
Alk. 1st Carb.	0.075	0.073	0.075	0.083	0.082	0.083	0.080	0.083	0.083	0.099
pH 2nd Carb.	9.3	9.1	9.1	8.9	8.8	---	9.3	9.3	9.4	---
pH Thin juice	7.9	7.8	8.0	8.1	8.1	7.9	7.9	7.9	8.2	---
pH Thick juice	8.4	8.2	8.2	9.0	8.5	8.6	8.6	8.4	9.2	---
pH White pan	8.4	8.3	8.6	8.7	8.0	8.2	8.6	8.3	8.9	8.6
Lime salts,1st Liq.	0.018	0.022	0.025	0.023	0.047	0.033	0.015	0.021	0.041	0.021
Sulphur used	0.51	0.57	0.47	0.62	0.48	0.54	0.50	0.57	0.64	0.63
Carbon used	0.11	0.10	0.05	0.07	0.15	0.09	0.00	0.00	0.16	0.07
Filter aid used	0.50	0.51	0.46	0.37	0.55	0.57	0.29	0.25	0.31	0.42
Sugar Analyses										
Ash,Carbonate %	0.0098	0.0132	0.0087	0.0103	0.0104	0.0136	0.0087	0.0088	0.0094	0.0119
" Sulphated %	0.0124	---	0.0109	---	0.0136	---	0.0112	---	0.0120	---
Color,B-K index	7.2	7.2	5.7	4.6	8.4	6.7	5.4	3.6	4.9	5.4
Turbidity index	16.8	16.1	11.8	9.5	18.2	19.0	13.9	10.0	13.4	12.6
SO_2, p/m	14	20	9	11	13	16	12	19	5	11
Formula rating	64.8	61.5	72.9	74.5	61.7	59.1	70.8	75.7	71.8	69.0
Foaming test	92-79	96-79	97-81	108-86	91-82	100-82	96-85	112-89	98-83	---
Reflectance	93.7	92.5	93.4	92.4	92.6	92.1	92.6	91.8	91.8	91.5
Candy-Color	12.7	14.6	10.2	11.2	14.4	13.3	11.8	10.3	9.8	13.1
" reducing sugs.	2.5	1.8	2.5	1.7	2.3	1.7	2.9	1.7	3.3	1.5
Total salts	0.0132	---	0.0115	---	0.0146	---	0.0114	---	0.0127	---
SO_3, p/m	17	12	22	12	17	14	19	10	24	12
Cl, p/m	6	13	6	6	10	20	12	11	11	14
Org. Acd., p/m	25	---	18	---	31	---	6	---	21	---
SiO_2, p/m	9	---	5	---	6	---	7	---	6	---
CaO, p/m	2	7	2	6	4	8	1	7	4	5
Salt composition approximated										
K_2SO_3, % salts	26.2	---	19.3	---	21.9	---	26.0	---	9.6	---
K_2SO_4, % salts	28.0	---	41.6	---	25.3	---	36.2	---	41.1	---
KCL, % salts	9.5	---	10.9	---	14.1	---	22.1	---	18.1	---
K Org., % salts	31.2	---	25.8	---	35.0	---	11.5	---	27.2	---
pH Sugar, electro	6.92	---	6.73	---	6.89	---	6.80	---	7.20	---
pH Candy, "	4.08	---	4.16	---	4.24	---	4.20	---	4.14	---
Cond.Fac.Carb.ash	264	---	279	---	269	---	272	---	276	---
" " Sulp. "	209	---	223	---	206	---	217	---	217	---
" " Salts	198	---	211	---	192	---	208	---	204	---
Yeast Inoculum Ind.	7.9	10.4	7.6	7.8	7.4	7.7	8.4	7.4	8.7	5.6

TABLE 15 - Continued
SUMMARY OF DATA FOR SELECTED FACTORY GROUPS
NON-STEFFENS

GROUP---	F		H		K		L		M	
	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9
Sucrose, beets	15.5	16.4	17.0	16.9	16.8	17.4	15.5	15.2	15.9	15.9
Juice Purity	87.2	86.5	84.9	83.2	87.9	87.1	84.7	83.6	86.1	84.6
Wht.pan purity	91.1	90.6	93.1	92.0	93.8	93.2	92.8	91.8	90.8	90.2
Diff.pur. J to P	3.9	4.1	8.2	8.8	5.9	6.1	8.1	8.2	4.7	5.6
Hi-green purity	84.0	82.2	87.3	84.6	86.2	86.3	85.9	84.3	82.4	81.4
Drop in purity	7.1	8.4	5.8	7.4	5.8	6.9	6.9	7.5	8.4	8.8
Lime used per ton	2.29	2.48	2.87	---	2.50	2.80	2.22	2.40	2.49	2.63
Soda Ash used	0	0.03	0.07	0.42	0.22	0.51	0.15	0.18	0.02	0.08
Alk.,1st carb.	0.093	0.094	0.085	0.083	0.072	0.072	0.088	0.086	0.086	0.087
pH, 2nd carb.	---	---	---	---	9.0	9.1	---	---	8.7	---
pH, thin juice	8.5	8.5	---	---	8.5	8.4	8.5	8.3	8.4	8.0
pH, thick juice	8.7	8.8	9.0	---	8.5	8.4	8.0	7.9	8.8	8.3
pH, white pan	8.3	8.2	9.0	8.6	8.3	8.2	7.9	7.6	8.4	8.0
Lime salts,1st Liq.	0.036	0.067	0.038	0.040	0.038	0.039	0.045	0.054	0.037	0.070
Sulphur used	0.46	0.39	0.22	0.51	0.25	0.41	0.52	0.66	0.42	0.40
Carbon used	0.08	0.04	0.06	0.03	0.12	0.07	0.16	0.12	0.10	0.14
Filter-aid used	0.50	0.45	0.67	0.43	0.49	0.61	0.56	0.55	0.45	0.48
Sugar Analyses										
Ash,Carbonate %	0.0097	.0100	.0065	.0108	.0060	.0060	.0072	.0100	.0126	.0122
" Sulphated %	0.0123	--	.0109	--	.0078	--	.0090	--	.0162	--
Color, B-K index	8.9	7.4	4.9	6.1	10.5	5.9	7.6	5.6	8.1	7.9
Turbidity index	17.9	15.5	11.5	11.8	18.7	9.8	13.2	12.7	17.7	16.1
SO_2, p/m	8	10	2	8	4	8	7	16	5	12
Formula rating	62.7	66.1	74.9	70.5	64.4	77.5	71.3	70.1	61.1	62.6
Foaming test	94-83	93-80	92-80	92-77	88-78	92-78	95-83	97-82	96-86	101-90
Reflectance	92.1	90.9	93.0	92.2	93.6	91.7	93.3	92.0	92.0	90.5
Candy-Color	13.6	14.7	11.4	12.3	9.4	9.8	10.2	12.6	16.2	14.5
" reducing sugs.	2.5	1.6	2.4	1.6	3.0	1.8	2.2	1.8	2.1	1.6
Total salts	0.0139	---	.0124	---	.0086	---	.0095	---	.0184	---
SO_3, p/m	16	7	16	7	15	6	14	8	19	13
Cl^-, p/m	2	6	9	9	3	7	2	5	3	8
Org.Acd.Rad. p/m	47	---	44	---	31	---	16	---	65	---
SiO_2, p/m	4	---	8	---	7	---	6	---	4	---
CaO, p/m	4	11	4	10	3	7	7	8	4	10
Salt Composition Approximated										
K_2SO_3 % salts	14.2	---	3.9	---	11.2	---	16.2	---	6.6	---
K_2SO_4 % "	25.0	---	28.0	---	37.1	---	32.0	---	21.8	---
KCl % "	3.0	---	15.2	---	7.1	---	4.4	---	3.4	---
K Org. % "	55.7	---	53.5	---	58.1	---	27.7	---	58.3	---
pH sugar electro.	6.75	---	6.97	---	6.78	---	6.55	---	7.25	---
pH candy "	4.31	---	4.17	---	4.12	---	4.10	---	4.24	---
Cond.Fac.Carb.ash	248	---	276	---	255	---	235	---	252	---
" " Sulp. "	195	---	217	---	199	---	190	---	195	---
" " Salts	173	---	190	---	174	---	178	---	173	---
Yeast Inoculum Ind.	10.8	8.4	10.8	9.4	10.8	7.2	9.3	12.8	12.2	12.7

TABLE 16

SUMMARY OF DATA FOR SELECTED FACTORY GROUPS
STEFFENS

GROUP---	A		B		C		D		E	
	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9
Sucrose, beets	15.9	16.5	14.6	15.8	16.0	15.9	15.6	16.1	15.0	15.5
Juice Purity	88.1	88.5	86.3	86.7	87.2	87.3	88.0	87.4	85.7	85.5
Wht.Pan Purity	92.6	92.3	91.5	91.2	91.7	91.9	92.7	92.0	91.7	91.7
Diff.Pur. J to P	4.5	3.8	5.2	4.5	4.5	4.6	4.7	4.6	6.0	5.2
Hi-green Purity	86.9	86.7	85.3	84.7	85.8	85.7	86.1	85.3	84.4	84.5
Drop in Purity	5.7	5.6	6.2	6.5	5.9	6.2	6.6	6.7	7.3	7.2
Lime used per Ton	3.33	3.59	3.17	3.53	4.02	3.57	3.38	3.96	3.52	4.10
Lime per 1% Mol.	0.59	0.63	0.59	0.62	0.55	0.54	0.57	0.61	0.56	0.62
Molasses worked %	5.62	5.72	5.39	5.68	7.29	6.61	5.90	6.54	6.26	6.60
Soda Ash used	0.38	0.36	0.17	0.04	0.78	0.36	0.17	0.08	0.67	0.26
Alk., 1st Carb.	0.075	.072	.069	.76	.065	.065	.074	.082	.071	.076
pH, 2nd Carb.	9.1	8.9	9.0	8.9	8.8	9.0	9.1	9.0	9.2	9.1
pH, Thin Juice	8.1	8.0	8.1	8.2	8.2	8.0	7.9	8.0	8.0	7.9
pH, Thick Juice	7.9	7.6	8.7	8.4	8.0	8.1	8.2	8.2	8.2	8.3
pH, Wht. Pan	7.9	7.6	8.6	8.4	7.9	7.7	8.2	8.2	8.2	8.2
Lime Salts, 1st Liq.	0.045	.040	.030	.022	.058	.040	.027	.014	.042	.023
Sulphur used	0.36	0.45	0.46	0.60	0.35	0.37	0.37	0.54	0.52	0.65
Carbon used	0.10	0.04	0.03	0.00	0.09	0.08	0.01	0.00	0.08	0.04
Filter-aid used	0.60	0.67	0.42	0.37	0.67	0.47	0.41	0.35	0.55	0.46
Sugar Analyses										
Ash, Carbonate	0.0103	.0123	.0126	.0131	.0108	.0135	.0097	.0116	.0123	.0137
Ash, Sulphated	0.0132	---	.0162	---	.0144	---	.0126	---	.0160	---
Color B-K index	9.0	11.9	6.6	5.8	11.6	12.9	6.0	5.0	6.0	4.6
Turbidity index	13.5	18.6	12.9	16.9	19.8	24.2	13.0	14.1	12.1	10.3
SO_2 in sug. p/m	7	13	7	13	6	9	9	16	11	17
Formula rating	66.5	55.9	67.2	62.9	57.2	48.5	70.4	67.7	68.5	69.7
Foaming Test	92-84	104-91	101-88	111-86	95-90	99-84	91-82	98-88	92-82	99-86
Reflectance	94.4	92.8	92.8	92.2	92.8	93.1	92.9	92.1	93.6	92.7
Candy Color	12.7	14.2	15.4	13.2	14.7	15.2	10.7	12.1	11.3	11.6
" reducing sugs.	2.6	1.8	2.5	1.5	2.6	1.7	2.3	1.6	2.8	1.6
Total Salts	0.0148	---	0.0180	---	0.0165	---	0.0138	---	0.0173	---
SO_3, p/m	18	9	22	10	17	8	20	10	23	19
Cl, p/m	6	8	10	8	6	14	6	10	15	18
Org.Acd.Rad. p/m	49	---	55	---	64	---	35	---	40	---
SiO_2, p/m	8	---	4	---	4	---	11	---	10	---
CaO, p/m	4	8	3	8	5	12	1	7	2	8
Salt Composition-Approximated										
K_2SO_3, % salts	11.7	---	9.6	---	9.0	---	16.6	---	15.7	---
K_2SO_4, % "	26.4	---	26.6	---	22.4	---	31.5	---	28.9	---
KCl, % "	8.5	---	11.6	---	7.6	---	9.1	---	18.2	---
K Org., % "	54.8	---	50.9	---	64.0	---	41.8	---	38.1	---
pH Sugar, electro.	6.69	---	7.17	---	6.58	---	6.80	---	6.72	---
pH Candy, "	4.16	---	4.23	---	4.33	---	4.26	---	4.16	---
Cond.Fac.Carb.Ash.	252	---	266	---	257	---	269	---	265	---
" " Sulp. "	198	---	209	---	194	---	204	---	208	---
" " Salts	176	---	186	---	168	---	189	---	188	---
Yeast Inoculum Ind.	8.9	8.7	9.4	8.6	6.6	8.5	6.2	8.8	6.0	6.2

TABLE 16 -Continued

Summary of Averages for Selected Factory Groups

STEFFENS

GROUP ---	F		H		K		L		M	
	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9	1940	1937-9
Sucrose, beets	15.5	15.8	17.5	17.1	17.7	17.8	14.3	14.9	16.9	15.2
Juice Purity	87.2	85.6	84.2	83.9	87.3	86.7	82.9	82.5	86.0	83.6
Wht.Pan Purity	92.9	91.5	92.1	91.8	93.7	93.5	90.8	90.4	92.1	92.1
Diff.Pur. J to P	5.7	5.9	7.9	7.9	6.4	6.8	7.9	7.9	6.1	8.5
Hi-green Purity	86.4	83.3	84.4	84.1	87.9	87.2	83.1	82.5	85.3	83.0
Drop in Purity	6.5	8.2	7.7	7.7	5.8	6.3	7.7	7.9	6.8	9.1
Lime used per ton	4.20	4.49	3.95	3.90	3.87	4.52	3.87	4.24	4.48	4.35
Lime per 1% Mol.	0.79	0.80	0.60	0.67	0.54	0.52	0.59	0.55	0.66	0.65
Molasses Worked %	5.31	5.61	6.54	5.82	7.47	8.74	6.59	7.71	6.76	6.74
Soda Ash used	0.57	0.86	1.33	1.74	0.76	0.91	0.72	0.27	0.61	0.42
Alk.,1st Carb.	0.085	.087	.086	.086	.072	.071	.078	.071	.084	.071
pH 2nd Carb.	8.9	8.8	9.1	9.0	9.3	9.0	8.8	8.6	8.7	8.6
pH Thin Juice	8.7	8.7	9.1	8.4	8.5	8.3	8.4	8.0	8.3	8.4
pH Thick Juice	8.7	8.8	7.8	8.0	8.2	8.1	8.0	8.0	8.6	8.5
pH Wht.Pan	8.3	7.8	8.0	7.5	8.2	7.9	7.9	7.6	8.1	7.9
Lime Salts,1st Liq.	0.045	.080	.080	.074	.077	.071	.085	.075	.073	.117
Sulphur used	0.36	0.41	0.36	0.40	0.28	0.37	0.44	0.49	0.28	0.27
Carbon used	0.23	0.17	0.12	0.10	0.08	0.04	0.20	0.23	0.12	0.14
Filter-aid used	0.81	0.85	0.73	0.70	0.44	0.48	0.44	0.39	0.69	0.63
Sugar Analyses										
Ash,Carbonate %	0.0108	.0103	.0076	.0090	.0071	.0076	.0119	.0144	.0115	.0121
Ash,Sulphated %	0.0138	--	.0095	--	.0093	--	.0150	--	.0146	--
Color,B-K index	8.8	10.1	9.1	9.1	9.7	6.5	8.9	9.6	11.4	11.7
Turbidity index	17.5	16.4	14.6	18.5	12.2	9.1	14.7	18.2	22.2	17.2
SO_2 in sug. p/m	6	5	3	4	2	5	5	6	5	4
Formula rating	6.3	62.7	68.4	63.0	70.8	76.3	64.0	57.2	54.4	58.6
Foaming Test	92-81	96-81	112-82	96-81	99-84	99-83	92-82	93-83	94-82	97-83
Reflectance	91.7	90.5	93.3	91.9	93.3	91.9	93.3	91.9	92.3	90.5
Candy-Color	14.6	16.3	9.8	10.7	9.1	10.3	13.8	14.7	15.9	17.5
" reducing sugs.	2.5	1.7	3.0	1.8	2.5	1.6	2.8	1.9	2.6	1.6
Total Salts %	0.0156	--	0.0103	--	0.0109	--	0.0166	--	0.0170	--
SO_3, p/m	18	6	17	10	11	5	18	16	17	10
Cl , p/m	3	6	5	11	1	6	13	13	1	4
Org.Acd.Rad.,p/m	53	--	24	--	47	--	47	--	72	--
SiO_2, p/m	6	--	6	--	10	--	13	--	9	--
CaO ,p/m	3	11	5	11	4	8	5	9	6	13
Salt Composition Approximated										
K_2SO_3, % salts	9.5	--	7.1	--	4.5	--	7.4	--	7.2	--
K_2SO_4, % salts	25.1	--	35.9	--	21.9	--	23.6	--	21.7	--
KCl , % salts	4.0	--	10.1	--	1.9	--	16.4	--	1.2	--
K Org.,% salts	56.0	--	38.9	--	71.1	--	46.7	--	69.8	--
pH sugar, electro.	6.71	--	6.53	--	6.70	--	6.75	--	6.77	--
pH candy,electro.	4.35	--	4.25	--	4.30	--	4.25	--	4.36	--
Cond.Fac.Carb.Ash	254	--	253	--	246	--	253	--	252	--
" " Sulp.Ash	199	--	203	--	187	--	200	--	197	--
" " Salts	176	--	186	--	161	--	181	--	171	--
Yeast Inoculum Ind.	9.2	7.1	6.5	7.6	9.3	5.8	5.3	10.7	6.7	7.7

PART II.

REPORT ON BIOLOGICAL STUDIES OF SUGARS

By H. H. Hall,
Food Research Unit.

The data presented in this part of the report concern the biological quality of the sugars. The samples were examined to determine the relative amounts of substance which stimulate the growth of yeast in sugar solutions and which, therefore, help to determine the suitability of the sugar for use in the manufacture of beverages. Examination of the samples was likewise made for various bacteria, yeasts and molds which influence the suitability of the sugar for use in canning, manufacture of beverages and dairy products.

The data were obtained by the examination of samples described in the preceding part of the report, and the same identification numbers have been used. The results are given in two parts, namely; (1) the examination for yeast stimulating substances, and (2) the examination for thermophilic and mesophilic microorganisms.

EXAMINATION FOR YEAST-STIMULATING SUBSTANCES

A number of years ago it was observed that beverages and solutions made from certain sugars were more susceptible to spoilage by yeast growth than were those made from sugars more highly refined. This indicated that a substance or a combination of substances was present in the sugar which stimulated the growth of microorganisms. A study was then undertaken to determine the nature of the stimulant, its significance in bottled beverages and the relationship of its presence to that of other impurities occurring in sugar. A summary of these studies is presented in this section of the report together with the results obtained by the examination for yeast growth stimulants of the 1940 campaign composite samples.

The necessity of yeast growth-promoting substances in the large scale manufacture of yeast and in fermentation reactions has long been realized and many extensive investigations have therefore resulted in an attempt to determine the exact identity of the stimulant. Two very comprehensive reviews of the literature concerning studies on yeast stimulants, or "bios" through 1930 have been published, as follows: "The Bios Question" by F. W. Tanner, published in Chemical Reviews, vol. I, 397 - 472, (1924), and "Review of Bios" by W. L. Miller, published in the Journal of Chemical Education, vol. 7, 257 - 267, (1930). Since these reviews were published, numerous articles have appeared in scientific publications concerning pantothenic acid which is a chemical complex also having yeast growth-promoting properties. The following articles are of special interest: Williams, R. J., Mosher, W. A., and Rohrmon, E., The Importance of Pantothenic Acid in Fermentation Respiration, and Glycogen Storage, Biochemical Jour., vol. 30, p. 2036 (1936); Addinall, C. R., The Discovery, Isolation and Synthesis of Pantothenic Acid, The Merck Report, vol. 50, no. 1, p. 41, (1941); and Wallerstein, J. S., New Facts About Growth Substances, Wallerstein Laboratory Communications, vol. 4, No. 11, (1941).

In recent years much new information has been obtained regarding the identity of the bios complex and the manner in which it functions in yeast metabolism. The known components of bios, which are classified as growth substances and not as nutrients are: inositol, vitamin B_1, beta-alanine, biotin, vitamin B_6 (for certain yeasts) and pantothenic acid. These substances which occur in nature in minute amounts act as catalysts rather than as yeast foods. The presence of relatively large amounts of these stimulants in molasses contributes to its value in the manufacture

of yeast and in alcoholic and acid fermentations.

The significance of yeast-stimulating substances in white sugar has previously been discussed in an article, entitled "Yeast Growth Stimulants in White Sugars," by Hall, James and Stuart, published in Ind. Eng. Chem., vol. 25, p. 1052, (1933). Briefly, the presence of sufficient amounts of these stimulants in sugar used in the manufacture of beverages will, when contaminated with yeast, cause the yeasts to reproduce to such an extent that the crop becomes visible and the beverage is rendered unsaleable. The nature and properties of the substance place it in the same category as the above named stimulants. No attempt was made to identify exactly the chemical components of the stimulant, but rather to determine its relationship to other known substances. Its properties, which are similar to those of other known yeast growth-promoting substances, are as follows: organic; s soluble in 80-percent alcohol; heat stable: resistant to hot and cold alkali treatment; and contains two or more fractions. Although the stimulant is an organic substance, its presence in sugar is correlated with the ash content as shown later in this section of the report.

The location of stimulating substances with respect to the surface of sugar crystals was determined and reported in an article, "Crystal Surface Contaminants and Biological Quality of Sugar", by Hall and James, published in "Facts About Sugar," June, 1936. It was found that these substances are located at or near the crystal surface and that elimination is facilitated by the complete removal of mother liquors from the white sugar. Processing improvements made during recent years have resulted in improving sugar quality and in reducing the amount of stimulants to a point where it is felt that it is no longer necessary to consider this substance as a hazard to thebeverage industry. Further work on this phase

TABLE I

Ranking of Sugar Samples Collected During 1940 Campaign

Sample Number	Rank	Yeast Inoculum Multiple	Sample Number	Rank	Yeast Inoculum Multiple
4032	1	1.1	4007	21	5.4
4009	2	1.5	4018	22	5.7
4002	3	2.2	4019	23	5.7
4023	4	2.3	4028	24	5.7
4012	5	3.0	4052	25	5.7
4015	6	3.4	4078	26	5.7
4050	7	3.4	4080	27	5.7
4017	8	3.8	4079	28	6.1
4085	9	3.8	4016	29	6.4
4003	10	4.0	4022	30	6.5
4062	11	4.0	4057	31	6.5
4011	12	4.6	4053	32	6.6
4030	13	4.6	4077	33	6.6
4065	14	5.0	4039	34	6.7
4081	15	5.2	4045	35	6.7
4084	16	5.2	4047	36	6.7
4010	17	5.3	4055	37	6.7
4087	18	5.3	4064	38	6.7
4001	19	5.4	4069	39	6.7
4005	20	5.4	4058	40	7.3

TABLE I (continued)

Sample Number	Rank	Yeast Inoculum Multiple	Sample Number	Rank	Yeast Inoculum Multiple
4021	41	7.7	4037	64	10.0
4083	42	7.7	4063	65	10.0
4024	43	7.9	4066	66	10.0
4034	44	7.9	4020	67	10.1
4040	45	7.9	4043	68	10.1
4068	46	8.0	4051	69	10.5
4060	47	8.1	4026	70	10.9
4061	48	8.1	4054	71	10.9
4070	49	8.1	4075	72	10.9
4082	50	8.1	4086	73	11.1
4008	51	8.6	4046	74	11.3
4013	52	9.1	4025	75	11.4
4035	53	9.1	4038	76	11.5
4073	54	9.1	4048	77	11.5
4031	55	9.2	4076	78	11.7
4027	56	9.4	4029	79	11.8
4042	57	9.4	4072	80	12.1
4074	58	9.4	4071	81	12.3
4056	59	9.6	4033	82	12.5
4004	60	10.0	4067	83	12.9
4006	61	10.0	4041	84	14.2
4014	62	10.0	4044	85	16.5
4036	63	10.0	4059	86	18.0
			4049	87	18.4

of the sugar program will probably be discontinued.

This year the relative amount of stimulant was determined in the 87 samples by the method described in the report issued in 1932 and in the articles by Hall, James and Stuart. One hundred cubic centimeters of ten-percent solutions of each sugar were inoculated with approximately 50,000 yeast cells per c.c. The yeast crop that developed during three days of incubation was determined and calculated in terms of the multiple of the number of cells inoculated into each solution. The samples are ranked in ascending order of their yeast inoculum multiples and are identified by their Sample Numbers. The results are given in Table I, pages 42 and 43.

The results of the examination show that the average * amount of stimulating substance is less in the samples this year than in the campaign year of 1939. The average yeast inoculum multiple was 8.0 this year which is a 12.0 percent decrease from last year's average of 9.1. Again this year there is a correlation between the amount of stimulant and the ash content of the sugar. The average ash content of 40 samples having yeast inoculum multiples up to and including the average 8.0 is .0095 percent. The average ash content of 45 samples having multiples above 8.0 is .0104 percent.

BACTERIOLOGICAL EXAMINATION

The samples were examined for the presence and numbers of organisms such as would influence the use of the sugar in certain food products. The usual examination was made for thermophilic bacteria, in order to determine their suitability for canning purposes. Last year, for the first time,

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* Samples Nos. 4085 and 4087 not included in the average.

the bacteriological examination was extended to include the mesophilic organisms that influence the quality of dairy products (particularly sweetened condensed milk), frozen foods and desserts, beverages, etc.

The samples were examined for the following mesophilic organisms: "total aerobic" and "acid-producing" bacteria, yeasts, and molds. The method of examination is as follows: Twenty grams of sugar are weighed into a sterile 150-ml. flask marked to 100 ml. Sterile water is added to the mark and the flask is rotated until the sugar is dissolved. Duplicate one and five-ml. portions are transferred to petri plates. One set of plates is poured with dextrose-tryptone agar containing brom-cresol-purple for the detection and enumeration of total and acid-type bacteria. The second set of plates is poured with wort agar for the detection and enumeration of yeasts and molds. All plates are incubated at 30°C for 72 hours. The results of the examination for mesophilic organisms are given in Table II, pages 46, 47, and 48.

The examination of the samples for thermophilic bacteria was made according to methods recommended by the National Canners Association laboratory. The examination was for "total aerobic," "flat sour," "hard swell" and "hydrogen sulfide" types. References to various publications regarding the presence and significance of these types of microorganisms occurring in sugar have been given in previous reports. Several of these, repeated for the benefit of those who have recently undertaken bacteriological testing, are as follows:

Cameron, E. J. and C. C. Williams, (1938) The Thermophilic Flora of Sugar in its Relation to Canning, Jr. Bacteriology, vol. 15, page 31; Cameron, E. J. and J. Yesair, (1931) Sugar Contamination; Its Effect in Canning Corn, The Canner, vol. 72; Owen, W. L. and R. Mobley, (1932)

TABLE II

Bacteriological Examination of 1940 Sugars

	Thermophilic Bacteria				Mesophilic Organisms			
	Aerobes		Anaerobes		Aerobic Bacteria		Yeast	Molds
Sample Number	Total Count per. 10 g.	Flat Sour per 10 g.	Sulfide per 10 g.	Hard Swell % Tubes With Growth	Total per 1.0 g.	Acid per 1.0 g.	Total per 1.0 g.	Number Colonies per 1.0 g.
4001	30	30	0	0	32	25	0	0
4002	5	0	0	0	7	7	0	0
4003	0	0	0	0	40	3	0	1
4004	35	30	0	0	22	5	0	0
4005	5	5	0	0	170	80	0	0
4006	5	5	0	0	17	5	0	0
4007	60	45	0	0	35	20	1	1
4008	5	5	0	0	5	5	0	0
4009	0	0	0	0	15	0	0	1
4010	10	5	3	0	5	5	0	0
4011	15	10	0	0	30	30	0	0
4012	205	200	0	0	23	3	0	0
4013	360	340	0	17	32	5	0	0
4014	0	0	0	17	40	5	0	0
4015	20	20	0	0	120	20	0	0
4016	5	5	0	0	23	15	1	0
4017	0	0	0	17	13	3	0	0
4018	55	50	0	65	220	180	0	1
4019	35	10	0	0	20	15	0	1
4020	75	55	0	0	150	110	0	5
4021	5	5	0	0	50	8	0	2
4022	45	40	0	17	30	5	0	0
4023	15	10	0	0	15	15	0	1
4024	5	5	0	0	15	15	0	1
4025	15	5	0	0	15	15	0	1
4026	5	5	0	17	150	50	1	0

TABLE II (continued)

Bacteriological Examination of 1940 Sugars

	Thermophilic Bacteria				Mesophilic Organisms			
	Aerobes		Anaerobes		Aerobic Bacteria		Yeast	Molds
Sample Number	Total Count per 10 g.	Flat Sour per 10 g.	Sulfide per 10 g.	Hard Swell % Tubes With Growth	Total per 1.0 g.	Acid per 1.0 g.	Total per 1.0 g.	Number Colonies per 1.0 g.
4027	15	15	0	0	18	3	1	0
4028	0	0	0	33	18	8	0	0
4029	5	5	0	0	540	90	0	0
4030	0	0	0	17	70	25	1	1
4031	10	10	3	0	22	7	0	3
4032	5	5	0	0	15	5	0	1
4033	60	45	0	0	47	32	1	2
4034	5	5	0	0	470	470	0	12
4035	40	40	0	0	10	10	1	1
4036	5	5	0	0	28	15	0	11
4037	5	5	0	0	18	13	0	1
4038	5	0	0	0	55	15	0	2
4039	0	0	0	0	28	13	0	2
4040	10	5	0	0	100	45	0	8
4041	30	30	0	17	250	125	0	0
4042	5	5	0	0	45	35	1	1
4043	0	0	0	0	18	18	0	4
4044	0	0	0	0	9	6	0	0
4045	10	5	0	0	28	13	0	2
4046	0	0	0	0	18	18	0	2
4047	15	0	0	0	180	175	0	16
4048	75	35	0	0	63	35	1	0
4049	5	5	0	0	20	10	0	0
4050	5	5	0	0	43	15	0	6
4051	0	0	0	0	20	5	0	8
4052	40	40	0	0	35	20	0	1
4053	0	0	0	0	5	0	0	0
4054	50	40	3	0	103	13	0	0
4055	10	5	0	0	15	5	0	0
4056	10	0	0	0	90	38	0	25
4057	0	0	0	0	25	5	0	0

TABLE II (continued)

Bacteriological Examination of 1940 Sugars

	Thermophilic Bacteria				Mesophilic Organisms			
	Aerobes		Anaerobes		Aerobic Bacteria		Yeast	Molds
Sample Number	Total Count per 10 g.	Flat Sour per 10 g.	Sulfide per 10 g.	Hard Swell % Tubes With Growth	Total per 1.0 g.	Acid per 1.0 g.	Total per 1.0 g.	Number Colonies per 1.0 g.
4058	5	5	0	0	45	40	0	4
4059	415	360	0	0	75	15	0	8
4060	0	0	0	0	15	8	0	0
4061	0	0	0	0	13	5	0	0
4062	5	5	0	0	65	30	0	1
4063	20	15	0	33	13	8	0	2
4064	0	0	0	0	20	5	0	30
4065	0	0	0	0	10	5	0	2
4066	5	5	3	33	8	0	0	0
4067	5	5	0	0	8	3	0	0
4068	0	0	0	0	63	53	0	1
4069	100	70	0	0	8	3	0	0
4070	0	0	0	0	105	5	0	1
4071	0	0	0	0	6	3	0	0
4072	0	0	5	0	10	4	0	0
4073	60	40	0	0	55	40	0	0
4074	130	10	0	0	90	64	0	1
4075	20	20	0	0	20	20	0	0
4076	20	15	0	0	25	10	0	0
4077	0	0	0	0	26	19	0	0
4078	0	0	0	0	2	0	0	0
4079	0	0	0	0	10	7	0	1
4080	0	0	0	0	7	2	0	0
4081	0	0	0	0	29	16	0	0
4082	70	50	0	0	70	80	0	0
4083	20	15	0	0	12	12	0	0
4084	170	105	0	0	18	15	0	0
4085	120	85	0	0	60	33	1	0
4086	5	5	0	0	12	10	0	1
4087	0	0	0	17	7	3	0	0

Thermophilic Bacteria in Refined Cane Sugars, Ind. Eng. Chem., vol. 24, page 104; Calton, C. F. (1936) Thermophilic Contamination Within the Sugar Factory, Ind. Eng. Chem., vol. 28, page 1235; Cameron, E. J. (1938) Report on Methods for Detecting and Estimating Numbers of Thermophilic Bacteria in Sugar, Jr. Assoc. Official Agricultural Chemists, vol. 21, No. 3, page 457.

Attention is again called to the fact that, in order to be acceptable for use in canning, sugars must conform to certain bacteriological standards which limit the number of bacterial spores permitted. The maximum numbers of bacterial spores permitted by the National Canners Association, based on the examination of five samples from a single lot of sugar, are as follows:

Total Aerobic Thermophilic Spores:

"For the five samples examined, there shall be a maximum of not more than 150 spores per 10 grams in any one sample and an average of not more than 125 spores per 10 grams of sugar for the five samples."

Aerobic Flat Sour Spores:

"For the five samples examined, there shall be a maximum of not more than 75 spores per 10 grams in any one sample and an average of not more than 50 spores per 10 grams of sugar for the five samples."

Anaerobic Sulfide Spoilage Spores:

"These shall be present in not more than two (40 percent) of the five samples and in any one sample to the extent of not more than five spores per 10 grams."

Anaerobic Thermophilic Hard Swell Spores:

"These shall be present in not more than three (60 percent) of the five samples and in any one sample to the extent of not more than

four (65+ percent) tubes (method for testing)."

The suitability of the campaign composite samples of sugar for canning purposes is based on the minimum numbers of spores of any type permitted for five samples as shown by the above standards. For the purpose of this report the results from the campaign composite sample are considered equivalent to the average of the data obtained from five individual samples. The data obtained are shown in Table II, pages 46, 47 and 48.

Six samples (6.9 percent) failed to conform to the National Canners Association specifications for canning-grade sugar. This is an improvement over last year when 13.3 percent of the samples failed to meet the specifications. The reason for the failure of the samples to meet the standards was due to high total aerobic thermophilic and flat sour type bacteria counts. The total number of samples tested and passing canning-grade specifications since the 1935 campaign are given as follows:

Year	No. Samples Tested	No. Samples Passed	Percent Samples Passed
1940	87	81	93.1
1939	75	65	86.7
1938	77	74	96.1
1937	70	65	92.9
1936	70	59	83.6
1935	65	47	72.4

The examination for mesophilic organisms showed that eleven samples contained an excess of 100 aerobic bacteria per gram. Ten samples contained yeast but none more than one per gram. Ten samples contained five or more mold colonies per gram of sugar which may be taken as an indication of undue exposure of the sugar to sources of infection in the sugar end

of the factory, or in careless handling of the composite. Mold and yeasts are not sufficiently resistant to heat to withstand the high temperatures encountered in juices, sirups and massecuites. Although standards have not been adopted by the food industry as to the number of mesophilic organisms permitted in ingredients, some industries are reluctant to accept sugar with a total plate count in excess of 100 bacteria per gram. Still others accept sugar only on the basis of its nearly complete freedom from mold and yeast.

The variation in the extent of contamination by thermophilic bacteria from year to year within the same factory has proved of considerable interest. A comparison of the bacteriological quality based on total and flat sour counts for four years of samples from the six factories having high thermophilic bacteria counts in 1940 is given in Table III.

It is noted that during the years prior to the past campaign the sugar from the factory represented by sample 4012 has easily met the canning grade specifications. Sugars from factories represented by samples 4013, 4059 and 4085 which failed to meet the specifications in 1940 also failed to meet them in 1939. The 1938 sample of sugar from the factory represented by sample 4084 alone was not of canning grade quality in this group during that year. Bacterial contamination in white sugar can nearly always be traced to a definite cause. In the case of continued high bacteria counts some focal point of infection will usually be found which is not impossible to eliminate. The improvements that have been made in the bacteriological quality during the past few years are commendable and much credit is due to those operators who have taken steps to maintain bacteriological control.

The question of the validity of the bacteriological results obtained by the examination of the regular campaign composite samples has been

TABLE III

COMPARATIVE BACTERIA COUNT OF PAST THREE CAMPAIGN

COMPOSITES FROM FACTORIES PRODUCING HIGH COUNT SUGAR IN 1940

Bacteria Counts per 10 Grams

Sample Number	1940 T.- F.S.	1939 T.- F.S.	1938 T.- F.S.	1937 T. - F.S.
4012	205-200	10-10	5-0	30-20
4013	360-340	125-105	10-0	20-10
4059	415-360	100-85	5-0	20-5
4069	100-70	55-45	0-0	10-5
4084	135-105	85-50	200-55	25-20
4085	120-85	730-730	20-15	15-10

T. - Total Thermophilic Aerobic Bacteria Count.

F. S. - Flat Sour Type Bacteria Count

raised. This is because the samples are not prepared expressly for bacteriological examination and, also, because some samples are shipped to these laboratories in cloth bags instead of sealed glass, tin or paper containers. Information on this subject was obtained by making a comparison of the results of the examination of twelve samples composited expressly for bacteriological examination with the same samples composited and handled under the usual procedure. The special samples were shipped to the laboratory in sealed tin containers. The regular factory composite samples were shipped in tin, glass, cloth bag, cellophane or cloth bag-cellophane wrapped containers. The results of the examination of the samples prepared and handled as "special" and "regular" composites, together with information on the type of container used for shipping the samples, are given in Table IV.

A comparison of the results of the examination for thermophilic bacteria does not show any significant differences in the counts. There is no indication that increased contamination has resulted during the preparation and shipping of the regular composite samples as compared to the special composite samples. This bears out previous findings and indicates that differences observed in the counts by two laboratories testing the same sample are not due to the method of handling the samples.

The results show that only two of the regular composite samples, namely Nos. 4005 and 4064, contain significantly higher mesophilic bacteria or mold counts than the special composite samples. Both of these samples were packaged and shipped to the laboratory in cloth bags; one of them, No. 4005, was also contained in a cellophane bag. Increased contamination of the regular samples could result from two sources, namely, (1) cloth bags used for shipment, and (2) careless handling during compositing at the factory. The possibility of microorganisms gaining access to the samples

TABLE IV

COMPARISON OF BACTERIOLOGICAL RESULTS OF REGULAR VERSUS SPECIAL COMPOSITE SUGAR SAMPLES

Sample Number	Container	REGULAR COMPOSITE								SPECIAL COMPOSITE							
		Thermophiles/10 g.				Mesophiles/1.0 g.				Thermophiles/10 g.				Mesophiles/1.0 g.			
		T*	F.S.	H_2S.	H.S.	T.	A.	Yeast	Mold	T.	F.S.	H_2S.	H.S.	T.	A.	Yeast	Mold
4002	Cellophane.	5	0	0	0	7	7	0	0	5	5	0	0	10	3	0	0
4003	Cloth	0	0	0	0	40	3	0	1	10	10	0	0	37	25	0	0
4005	Cloth & Celloph.	5	5	0	0	170	80	0	0	0	0	3	0	50	25	0	2
4010	Tin	10	5	3	0	5	5	0	0	5	5	0	0	15	3	0	0
~~4016~~	Cloth	5	5	0	0	23	15	0	0	15	15	0	0	28	10	0	0
~~4019~~	Tin	35	10	0	0	20	15	0	1	5	5	0	0	64	8	0	1
4032	Cloth	5	5	0	0	15	5	0	1	0	0	0	0	5	0	0	0
4042	Cloth	5	5	0	0	45	35	0	1	0	0	0	0	48	45	0	0
4053	Glass	0	0	0	0	5	0	0	0	0	0	0	0	3	3	0	1
4058	Cloth	5	5	0	0	45	40	0	4	10	10	0	0	23	18	0	0
4064	Cloth	0	0	0	0	20	5	0	30	0	0	0	0	5	3	0	0
4072	Tin	0	0	0	0	10	4	0	0	0	0	0	17	15	5	0	1

*T – total count
F.S. – flat sour
H_2S – hydrogen sulfide
H.S. – hard swell
A – acid producing types

during compositing is perhaps greater than during shipment. The number of times which it is necessary to open the composite sample containers during the campaign would result in the introduction of a large number of organisms unless proper precautions were taken. In the absence of more conclusive information it can only be suggested that every possible precaution be taken to exclude the entrance of microorganisms into the composite sample. The practice of making several small composites in sterile containers during the campaign is highly recommended. It is also desirable to avoid as much as possible exposing the samples to open air or handling the samples in areas where the air is known to carry dirt or air movement is extensive. Finally, the shipment of the campaign composite samples to these laboratories in sealed containers known to be impervious to bacteria is highly desirable.

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The cooperation of the various sugar companies in submitting the samples and factory data which made these investigations possible is greatly appreciated. As a result of this cooperation there have been obtained data which should provide means of obtaining further improvements in the quality of the sugars. Further study of the factors which effect sugar quality will be pursued during the coming year.